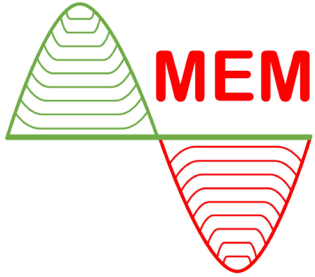


31/01/2025



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## **Ffos-y-Fran Final Restoration Scheme Acid and Metalliferous Drainage (AMD) Risk Assessment**

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**Submitted to:**

**Merthyr South Wales, Ffos-y-Fran, Wales,  
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## **Appendices**

Appendix A – Site visit memo

Appendix B – Overburden, soil and soil forming material analysis

Appendix C – Water quality data summary

## **1 INTRODUCTION AND BACKGROUND**

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### **1.1 Site overview and background**

Merthyr (South Wales) Ltd (MSW) have commissioned Mine Environment Management (MEM) to complete an Acid and Metalliferous Drainage (AMD) Risk Assessment to support the Environmental Statement (ES) for the Ffos y Fran Final Restoration Strategy. MEM understands that MSW intends to undertake the third and final restoration of the Ffos-y-Fran surface mine following cessation of coal extraction in November 2023.

The Ffos-y-Fran site lies approximately 1.5 km east of Merthyr Tydfil town centre. The site is relatively complex in terms of the current rehabilitation phases and coal extraction and historical mineral resource activities (coal and iron ore). Mining activities have been recorded on site at the earliest in the early 1800s, with numerous shafts, adits and spoil across the area (CEL, 1996), during coal excavation 46 known shafts and 39 known adits related to previous iron ore and coal workings were found.

As part of technical studies completed for this project by MEM, hydro-geochemical assessment has been carried out which mainly focuses on potential sources of soluble parameters of potential concern (e.g. manganese) which have the potential to influence site water quality following completion of the final rehabilitation plan. Potential sources include exposed pit walls, backfill material within the pit void, overburden material placed in OB1, OB2 and OB3 and other sources not related to the recent mining operations such as drainage from old mine workings (adits) and offsite sources such as landfills. These sources may produce runoff or seepage which could have a higher load of dissolved and or suspended solids or parameters of potential concern which then have potential to flow into identified receiving hydrological and hydrogeological waterbodies described on site as well as those downgradient identified as relevant receptors.

A number of previous hydrological and hydrogeological assessments have been undertaken on the site and are described in the hydrogeological and hydrological reports for the ES.

A hydrogeological assessment was undertaken by R.G Edwards (Independent Consulting Engineering Geologist) and reported in the Environmental Statement for the original Ffos-y-Fran Land Reclamation Scheme. The assessment found that the mine water quality was generally good with no elevated contaminants and waters are typically alkaline with a high capacity to neutralise any acidic discharge and therefore the potential for significant acid rock drainage was considered to be low.

The main purpose of the hydro-geochemical assessment is to describe the potential impacts of the restoration scheme on surface water and groundwater quality in identified receiving waterbodies.



The geochemical risks related to remaining exposed mine related rock or soil has also been considered, although this is assumed to be of lower concern (relative to water quality) as for the most part areas containing these materials will be reseeded and revegetated.

The scope of the assessment includes development of an acid mine drainage risk assessment to cover the pit void and overburden sites, with one of the main outcomes of the study comprising a technical assessment of the likely future water quality of the waterbody formed in the pit void.

## 1.2 Restoration plan features relevant to AMD risk assessment

The full restoration plan is described in the Environmental Statement. The main points of note with respect to the AMD risk assessment are identified as follows:

- Reduction in height and reprofiling of OB1, which is likely to stabilise the landform further and reduce potential erosion of material. Material moved from OB1 will be used as backfill in the pit void.
- The main void is partially filled (i.e. not complete backfill so some void will remain) with material recovered from the site. A lake will form in the pit void. Following cessation of pumping the lake level rose to equilibrate with the surrounding groundwater level and fluctuates seasonally. As such, the lake has been incorporated into the scheme as a permanent body of water.
- Overburden and backfill areas will be revegetated by numerous methods such as hydroseeding, natural revegetation and some areas of tree planting.
- The steep back wall of the open pit will not be actively revegetated.
- Partial restoration of slopes on OB2 and OB3.
- A five (5) year maintenance period was included in the restoration plans.

## 1.3 Permitting and legislation

### 1.3.1 Final operational permits

The mine currently has the following permit documents pertinent to water quality:

- Permit number EPR/DB3131AF
- Consolidated permit number AE2013403
- Variation and consolidation application number PAN-018818, 9<sup>th</sup> August 2023 – inclusion of flocculent
- Variation and consolidation application number PAN-018819/PAN-018820

The permits relate to activities at the site during active operations with the activities listed within the permits. The discharge points listed for the site are shown in Figure 1.

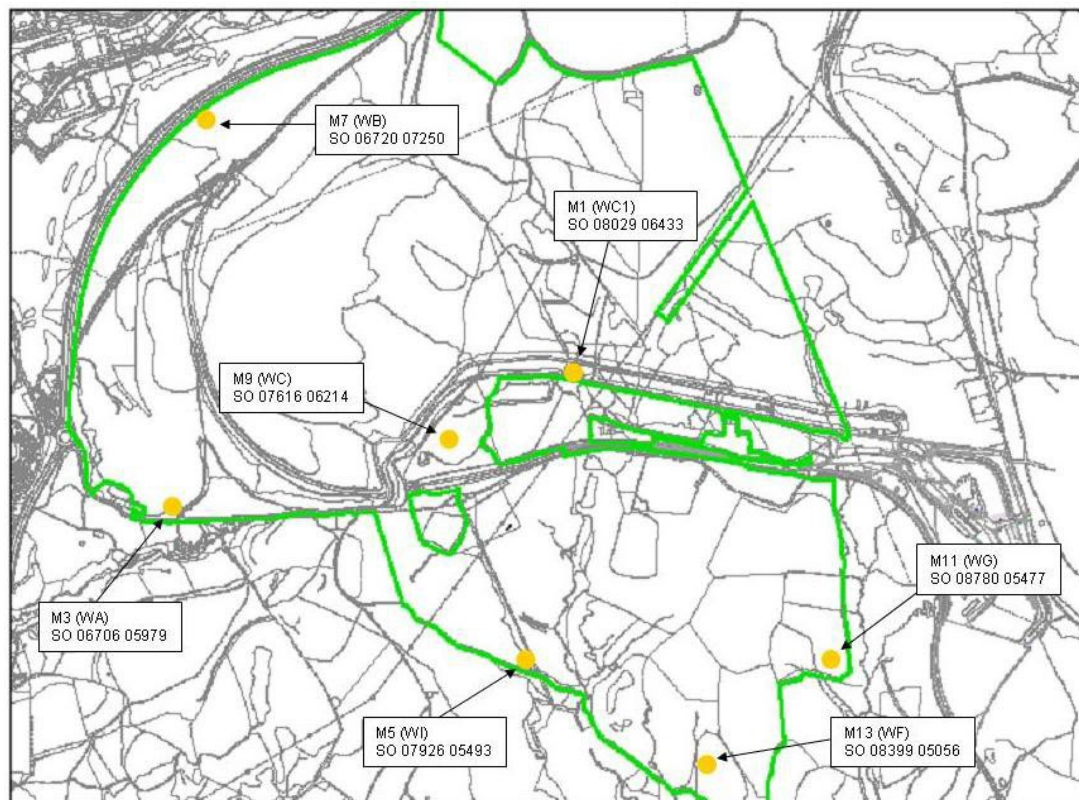


Figure 1 Final effluent locations listed in permits

During operations the site held a permit (AE2013403) through NRW to discharge into local waterbodies. The permit allowed for variable discharge volume dependent on rainfall, with limits for suspended solids, pH, visible oil and grease and iron (the latter introduced during a permit variation in 2016). Monitoring data is collected and reported at seven (7) points at the site or just downstream. Monitoring data suggests that water discharging from the site is found to be generally within these set limits. The limits were set for the following parameters, although not all limits are applied at each discharge location (depending on flow conditions and situation):

- Suspended solids – variable, but as low as 50 mg/L from January 2026
- pH – 5 – 9
- Iron – 3 mg/L
- Visible oil – no significant presence

As part of the planning conditions for mining at the Ffos y Fran site, a groundwater monitoring scheme to protect groundwater was required to be in place as part of condition 44 and approved by the planning authority. The frequency, parameters measured and trigger levels for parameters were agreed with authorities and regulators in 2003.



Water quality was originally monitored at 17 locations, surface water, culverts, boreholes and piezometers (Table 1), however these locations have reduced due to either access or boreholes no longer being available. Flow testing and water level records are also maintained. Condition 44 requires groundwater water quality samples are taken on a quarterly basis, although should trigger levels for parameters be breached sampling frequency increases to monthly. Surface water quality is monitored quarterly, but also required after specific dry periods or storm events for the River Taff, Bargoed Taf, River Rhymney and culvert locations in sample points 1 – 10. The following parameters are required to be monitored:

- Primary parameters:
  - pH, EC, TSS, BOD, COD, TOC
  - Ca, Mg, K, Na, NH<sub>3</sub>, Fe (total)
  - Alkalinity, SO<sub>4</sub>, Cl, NO<sub>2</sub> and NO<sub>3</sub> as N
  - Total volatile fatty acids (VFA)
- Secondary parameters:
  - DO
  - Ba, B, Al, Mn, Cu, Pb, Zn
  - S, F, P
  - Total PAHs, Total PCBs, Phenols
- Tertiary parameters:
  - As, Hg, Se, Mo, Cd, Cr, Ni
  - VFAs suite, PAHs suite, PCBs suite, OCPs, OPPs

Table 1 Monitoring locations required for Condition 44

| Sample Point | Description & Location                            | Quality Testing | Flow Testing | Water Level Recording | Depth of Borehole (Meters) |
|--------------|---------------------------------------------------|-----------------|--------------|-----------------------|----------------------------|
| 1            | Nant Morlais Inlet Z3                             | v               | v            |                       |                            |
| 2            | Nant Morlais Culvert Z1 (Near Black Ball Outfall) | v               | v            |                       |                            |
| 3            | Nant Morlais Outlet Z                             | v               | v            |                       |                            |
| 4            | Penyrheol Culvert (At Ty Coed Bungalow)           | v               | v            |                       |                            |
| 5            | Concrete Culvert at Site Discharge Point EA       | v               | v            |                       |                            |
| 6            | Culvert Outlet into Bargod Taf                    | v               | v            |                       |                            |
| 7            | Nant Gyrawd Upstream of Bargod Taf (EA 17043)     | v               | v            |                       |                            |
| 8            | Bargod Taf Downstream of Nant Gyrawd              | v               | v            |                       |                            |
| 9            | Upstream of Rhymney Culvert                       | v               | v            |                       |                            |
| 10           | Pontlottyn Bridge (EA 18013)                      | v               | v            |                       |                            |
| 11           | Borehole 5808                                     | v               |              | v                     | 127.0                      |
| 12           | Borehole 5817                                     | v               |              | v                     | 150.0                      |
| 13           | Borehole 5821                                     | v               |              | v                     | 192.5                      |
| 14           | Borehole 5823                                     | v               |              | v                     | 138.0                      |
| 15           | Borehole 5824                                     | v               |              | v                     | 95.5                       |
| 16           | New Piezometer SC1                                | v               |              | v                     | 165.0                      |
| 17           | New Piezometer SC2                                | v               |              | v                     | 178.0                      |

Pollution alert trigger values (PAVs) were derived based on baseline dataset (pre-2003) using Miller Argent, historic Environment Agency data and Celtic Energy data. These trigger alerts were designed to show where a value might be greater than the current range for the site and be an indicator of a potential pollution issue that requires investigation or mitigation. The PAVs are described in Table 2. Where trigger levels are exceeded additional monitoring and investigation occurs. Data and exceedances of PAVs are provided to the NRW. Reviews of the data with the NRW were agreed quarterly and then annually (from 2015) as the site was considered to be a low level of concern by NRW.

Table 2 Current site pollution alert values (PAVs)

| Parameter | Unit  | Pollution Alert Value (PAV) |
|-----------|-------|-----------------------------|
| pH        | s.u.  | 6.5 - 8.5                   |
| EC        | µS/cm | 2,000                       |
| TSS       | mg/L  | 50                          |
| BOD       | mg/L  | 6                           |
| DO        | mg/L  | <5                          |
| Ca        | mg/L  | 250                         |
| Mg        | mg/L  | 100                         |



| Parameter            | Unit                      | Pollution Alert Value (PAV) |
|----------------------|---------------------------|-----------------------------|
| K                    | mg/L                      | 40                          |
| Na                   | mg/L                      | 170                         |
| Fe                   | mg/L                      | 1                           |
| As                   | mg/L                      | 0.01                        |
| Hg                   | mg/L                      | 0.001                       |
| Se                   | mg/L                      | 0.01                        |
| Ba                   | mg/L                      | 0.5                         |
| B                    | mg/L                      | 0.3                         |
| Al                   | mg/L                      | 0.5                         |
| Mn                   | mg/L                      | 0.25                        |
| Cu                   | mg/L                      | 0.2                         |
| Pb                   | mg/L                      | 0.1                         |
| Zn                   | mg/L                      | 0.1                         |
| Se                   | mg/L                      | 0.01                        |
| Mo                   | mg/L                      | 0.05                        |
| Cd                   | mg/L                      | 0.005                       |
| Cr                   | mg/L                      | 0.03                        |
| Ni                   | mg/L                      | 0.1                         |
| Alkalinity           | mg/L<br>CaCO <sub>3</sub> |                             |
| SO <sub>4</sub>      | mg/L                      | 400                         |
| Cl                   | mg/L                      | 250                         |
| N                    | mg/L                      | 5                           |
| Ammoniacal N         | mg/L                      | 0.5                         |
| S                    | mg/L                      | 0.03                        |
| F                    | mg/L                      | 1.5                         |
| P                    | mg/L                      | 0.2                         |
| VFA                  | mg/L                      | 40                          |
| PAH (totals)         | ug/L                      | 0.2                         |
| PCB (totals)         | ug/L                      | 1                           |
| Phenols (monohydric) | mg/L                      | 0.5                         |
| VFAs species         | ug/L                      | 5                           |
| PAHs species         | ug/L                      | 0.2                         |
| PCBs species         | ug/L                      | 0.01                        |
| OCPs species         | ug/L                      | 0.01                        |
| OPPs species         | ug/L                      | 1                           |

An Extractive Materials Management Statement completed in 2010 on the FLRS included some basic samples and analysis of materials on the site, and an overview of the volume of overburden in the storage areas and volume removed from the pit void. The document also describes some of the soil and geology on the site, as well as the current water treatment areas on the site (mostly series of settlement ponds for sediment).

As required by legislation (at the time), the EMMS classified waste to be handled on site. Overall the quantity of material to be extracted on site was expected to be 125,527,999 cubic metres (including soils). Around 80% of this material is classified as overburden, other materials included barrel wash rejects, settlement pond silts, superficial material and colliery spoil. The overburden was classified as inert based on chemical testing of the material (low sulfide and metals content) with respect to the EC Directive 2006/21/EC. Three overburden storage areas were considered to be utilised for the following periods of time:

- OB1 15 years
- OB2 14 years
- OB3 11 years

The site already had a number of existing areas of opencast spoil and backfill at the time of the 2010 EMMS, up to 30 m thick. Soils on the site are generally described as mixed, typically organic or peaty topped mineral soils, or those restored as part of the Trecatti opencast soil site. It has been stated there are no contaminated soils on site. The underlying geology is predominately Lower and Middle Coal Measures comprising mudstones, siltstones and occasional sandstones, coal seams, ironstones and seatearths. Coal has been extracted and sold in part to provide funding for the restoration strategy. Remaining suitable materials will be used for restoration works, including soil and soil forming material, with no additional processing expected to be required.

The original EMMS stated materials stored in OB1, OB2 and OB3 would be placed as backfill into the void and thus these overburden storage areas were classified as temporary. The overburden storage areas were all designed and managed, with associated inspection and reporting, to UK regulatory requirements at the time (e.g. Quarries regulations 1999 Code of Practice).

### ***1.3.1 Legislation and policy***

Relevant legislation and policy this assessment has taken into account includes the following regulatory, policy and guidance documents:

- The Water Environment (Water Framework Directive) Regulations (2017) which commits to achieving good status water environments, where good status is based on ecological and chemical protection.

The chemical status of a water body is determined by compliance with environmental quality standards for chemical substances prioritising hazardous chemicals. The aim of the water framework directive is for water bodies to achieve 'good overall status' and prevent deterioration.

- The Groundwater (Water Framework Directive) (Wales) Direction 2016 (2016 No. 14). Groundwater bodies are evaluated for chemical status as are those groundwater bodies which serve protected receptors, such as groundwater dependent habitats and/or public water supply abstractions. The aim of the groundwater directive to protect groundwater against pollution and deterioration and achieve good chemical condition.
- Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations (2017) as described are a guide to the requirements of the EIA assessment.
- Environmental Permitting Guidance: The Mining Waste Directive (2010) and corresponding guidance (How to comply with your environmental permit – Additional Guidance for Mining Waste operations (EPR 6.14), NRW, 204) which also includes relevant references for prevention of pollution of soil and water and the requirements of adequate closure of mined areas.
- Planning Policy Wales (Edition 12), Technical Advice Notes (TANs) and Circulars (including Minerals Technical Advice Note 2: Coal, Minerals Planning Guidance: The reclamation of mineral workings, Mineral Workings – Legal Aspects Relating to Restoration of Sites With a High Water Table (60/85))
- Directive 2006/21/EC on the management of waste from extractive industries. It is commonly referred to as the Mining Waste Directive (MWD). Although the UK is no longer in the EU, the MWD is a useful reference in absence of specific UK based mine waste legislation being produced.
- Relevant international guidelines include the International Council on Mining and Minerals (ICMM) Integrated Mine Closure: Good Practice Guide (2nd edition) 2009 which describes mine closure assessment as dynamic and iterative process that considers environmental, social and economic concerns.

In particular, the following points from the EPR mine waste permitting and guidance are considered pertinent to this assessment:

- Technical requirement for waste to be characterised and definitions for waste types (i.e. inert, non-hazardous, hazardous), as described in the EMMS for the site.
- A closure and aftercare procedure, including stabilisation and minimising negative effects, for mining waste is only required if the mine waste is classified as either Category A, Hazardous or Non-Hazardous. However, a waste management plan for all mine waste should still include the closure period.
- Requirements to prevent the deterioration of water and soil quality is required for most mine waste types, this includes a requirement for an environmental permit for site operation (as described above for Ffos y Fran).

- A mining waste facility is defined as an area for accumulation or deposit of extractive waste (and does not include backfill of a void area) and waste is held in the facility for certain periods of time, for inert waste this is three years.
- Inert waste is waste that will not react and which will not affect other matter in a way likely to rise to environmental pollution or harm human health. Overburden samples, as tested in the EMMS, were defined as inert waste. Inert waste is classified as that with low sulfide content and low risk metals and hazardous substances.
- The mine waste facilities at Ffos y Fran have not to date been classified as Category A facilities.
- The waste management plan requires the return of extractive waste to the void, where it is technically and economically feasible and environmentally sound.
- The long-term geotechnical stability of any above ground deposits needs to be ensured.
- If waste is placed back into a void the waste must be physically stable, pollution of soil and water prevented and appropriate monitoring of the void and the waste takes place for as long as necessary. Contaminated leachate or water should also be collected and if necessary treated prior to discharge in some cases. Mine waste stored in a void is not designated as a mine waste facility.
- Where waste is placed in flooded excavation voids, it must be demonstrated that water and soil status deterioration and pollution is not caused. Inert waste can be placed back into such a void, should the following be possible (unless the mining waste poses no potential hazard to water and treatment of leachate is not necessary):
  - Determination of the water balance of the waste facility, including evaluation of the volume and quality of leachate from the waste
  - Prevention or minimising leachate generation and preventing or minimising contamination of surface water, groundwater and soil
  - Collection and if necessary of potentially treatment of contaminated leachate or water
- The 'no potential hazard' in the above point is defined as any necessary measures would only provide a negligible contribution to meeting relevant environmental standards and preventing the deterioration of the water status (i.e. the mining waste facility would pose no potential hazard to water or soil), and any measures can be waived as the facility poses an acceptably low environmental risk.
- The quantity and quality of leachate and the overall water balance for mine waste facilities should be demonstrated for inert waste facilities for closure.
- Settlement ponds only managing clean runoff are not considered as part of the mine waste requirements.
- Monitoring and management of the mine waste should continue in the closure period until the facility no longer poses any unacceptable risk.



### *1.3.2 Assumptions and exclusions*

The following assumptions and/or exclusions have been made whilst completing this assessment:

- Historical mine workings and associated waste (related to activities prior to the current scheme) or offsite/upgradient landfill sources are not considered as part of the scheme and detailed assessment for the Hydrogeochemical study. However, they may be discussed generally in the Acid Mine Drainage Assessment if they are relevant to the likely future water quality.

## 2 BASELINE DESCRIPTION

### 2.1 Current site condition as baseline

The following section provides description of the current site condition used as the baseline for this assessment of the site. This is taken to be the recent environmental setting, being based on monitoring data and reports for the last 3 years. However, given the length of time data is available for the site, selected older data has been used to provide additional background information and comparison to establish differences in prior baseline conditions. The sources of data that have been used as part of the baseline and assessment include the following:

- Site visit and memo based on a visit by MEM staff in July 2024 (Appendix A)
- Analysis data from soil, overburden and soil forming materials sampled in July 2024 (Appendix B)
- Water quality database supplied by MSW (summarised in Appendix C)
- Additional water quality sampling data from areas around the ponds south of OB3 (Appendix C)
- Planning, EMMS and condition 44 documentation, including meeting notes from Condition 44 NRW/MSW meetings
- Groundwater reports previously completed for the site (CEL, 1996)
- Monitoring data and annual reports relating to the Trecatti waste management site accessed from NRW open access website October 2024
- Ecological assessment of the Bargod Taf watercourse (Aquilina, 2014)

Some of the key points for the site description and hydrogeochemical baseline based on the July 2024 site visit (Appendix A) are outlined based on MEMs understanding as follows:

- Historic workings are suspected and known across the site. Given the extent of areas worked historically (from 1800s) these historical activities have likely had (and may continue to have) an effect on local water flows and quality.
- Several sites of importance for nature conservation (SINC) are located near the site, but no reported impacts of the site have been noted by MSW.
- Site inspections by Natural Resources Wales (NRW) have regularly occurred over recent years, the frequency being lowered over time as the site was considered a lower risk.
- A historic landfill was located in a small area of the initial open pit void, however this was completely removed prior to current operations commencing.
- Biffa operate a waste management site to the northeast of Ffos y Fran. Groundwater monitoring has been completed at a number of boreholes located around the southern perimeter.
- Any areas of spoil or temporary stockpiles have been removed and all stored material is now in the three main overburden areas: OB1, OB2 and OB3. The overburden areas are not lined. Overburden is typically relatively homogenous.
- Silt from settling ponds was removed every few years and mixed with backfill material deposited in OB areas. The overall mass of silt removed is likely very low (compared to volumes of other waste materials), as such AMD risk is considered to be relatively low.

- Two areas of higher sulfur coal (~3 – 3.5% S) were stockpiled and capped within the eastern side of the pit. Based on the description of material handling it is assumed this material has been adequately encapsulated and is not open to the atmosphere. The volume/mass of this material is unknown.
- Backfill material also included relatively small amounts of discards from the barrel washing process, which amounted to around 50,000 tonnes/year. This material was used as part of the backfill material within the pit void.
- Along the eastern edge of the pit, in the final wall, the 'R' seam, which contains 4% sulfur, is exposed. Staining can be seen above and below this seam, indicating seepages likely contain elevated levels of species related to sulfide oxidation such as iron that are liable to precipitate out of solution to form "coloured" secondary minerals (Figure 2).



Figure 2 (top and bottom) Staining (orange) seen at seepages from 'R' seam

- During the site visit carried out by MEM, a relatively small area of potential AMD impacted surface water (yellow discolouration) was observed within the pit (Figure 3). It was explained by MSW site staff (during the site visit) that a small high sulfur (4% sulfur) coal stockpile (G-lower) was stored in the pit (now removed), and the decolourisation was possibly the result of this material stockpiling. MEM understands that this area will be monitored (and/or removed) to identify the nature of the impact and the source.



*Figure 3 Potential mining impacted surface water in the pit*

- Only minor seepages from the pit wall above the level of the pit lake was observed, mainly from the eastern pit wall, i.e. under OB1.
- A small surface water stream was visible on OB1 that drains into the pit. A sample of this stream was taken and analysed for a range of parameters by the MSW team.
- It was noted that shallow mining (~20m deep) was conducted when operations originally commenced to remove high sulfur coal seams near the southern edge of OB3. These coincide with an area of seepage at the toe of OB3.

## 2.2 Geology

The geology of the site is fully described in the Environmental Statement (ES) and as such to avoid duplication a brief summary has been provided herein, the reader is referred to the ES for further detailed description of site geology.

The geology of the site comprises mostly Lower and Middle Coal measures, which have been extensively mined. They mainly comprise mudrocks with occasional sandstone developments and numerous coal seams and ironstones.

The open pit void has some exposed rock walls which include the outcropping coal seams at these points. Strata dip mainly towards the south-east. The site is crossed by three major faults trending from north-west to south-east, one of which includes the Dowlais fault, which is present in the middle of the excavation area. Superficial deposits, other than made ground and backfill, include glacial till, and tend to be thickest (up to 13 m) towards the south and west of the site.

Spoil tips containing waste materials from mined areas are present and the pit void has been partially backfilled with excavated mine waste materials.

## **2.3 Hydrology and hydrogeology**

The hydrology of the site is fully described in the FCA and WFD reports (Waterco, 2025a and 2025b), as such the reader is referred to these reports for further detail on hydrology.

Surface water from the site drains to a number of surface water catchments. Surface water to the east (from OB2 and OB3) flows through Nant Gyrawd towards the Taff. The River Rhymney to the east does not have any main drainage connections from within the assessment area, as much of the drainage from the overburden and pit areas feeds to the River Taff catchment to the west. South of OB3 the drainage is through the Bargoed Taff towards the main Taff river. The Taff River runs west of the site, through Merthyr Tydfill. The western side of the site, mainly around the backfill drains via the Nant Cwm Blacs towards the Taff. The north eastern edge drains towards the culverted Nant Morlais and River Taff. Hydrological data for the Taff at Merthyr Tydfill (NRFA, 2024) suggests the Q50 flow to be 1.49 m<sup>3</sup>/s, with a low flow Q95 of 0.73 m<sup>3</sup>/s. The mean flow is 3.9 m<sup>3</sup>/s. The river has been gauged daily at this point since 1978.

The groundwater environment is fully described in the hydrogeology report (Groundwater Science, 2025) as such the reader is referred to this report for further detail on hydrology. Groundwater drainage at the site is controlled by inter-connected old mine workings and cross drives, including the Dowlais Free Drainage System (DFDS). The majority of the DFDS is thought to drain towards the Taff, however a portion does drain towards the Rhymney catchment. A groundwater divide sits to the east of OB1, most of the drainage from the pit void and overburden areas draining towards the Taff to the west, rather than towards the Rhymney to the east. The Dowlais Fault sits at the western edge of the pit void, and has been replaced by backfill where it cuts through the backfilled area of the void. The backfill used within the void is permeable and groundwater flow paths are not thought to be significantly changed between the backfill and the coal measures removed. Following cessation of operations the water level within the pit void has rebounded to a level which is at equilibrium with the surrounding groundwater levels, ~280 m RL. The water level of the pit void has been observed to fluctuate seasonally following its rebound, and it is expected to be highest in winter and lowest in summer.

## **2.4 Water quality monitoring**

Water quality monitoring at Ffos y Fran has been ongoing since pre 2003 by multiple owners of the site (Miller Argent and MSW). Much of the monitoring carried out was in line with permit and Condition 44 requirements. Monitoring locations in groundwater, surface water, settling ponds and the mine void are all included in the dataset. Monitoring is completed by Socotec on behalf of MSW. An overview of the monitoring points included in the MSW dataset are shown in Figure 4. The monitoring locations have been grouped by types to allow interpretation and comparisons. A summary of the data set including time series graphs can be found in Appendix C. Water quality data is compared against the PAVs set for the site. Date ranges for each monitoring point vary, as some locations became obsolete (for example groundwater locations in the pit void ceasing following excavation of that area). Monitoring at MA02 and MA03 (outfalls into Nant Morlais catchment) also stopped in 2020, which limits the ability to assess this area for potential recent variations and current baseline conditions as well as future impacts.

Parameters monitored are typically those described by the Condition 44 requirements, including physico-chemical indicators (pH, TDS, TSS), major ions, metals, nutrients and organic suites. Parameters include potential risks from the operational works such as organics relating to fuel use, nitrogen (from ANFO use), sulfate and metals for AMD risk. Other parameters, such as mecoprop and tritium were added due to the proximity of the Trecatti landfill to the site, and the potential risk from this source.

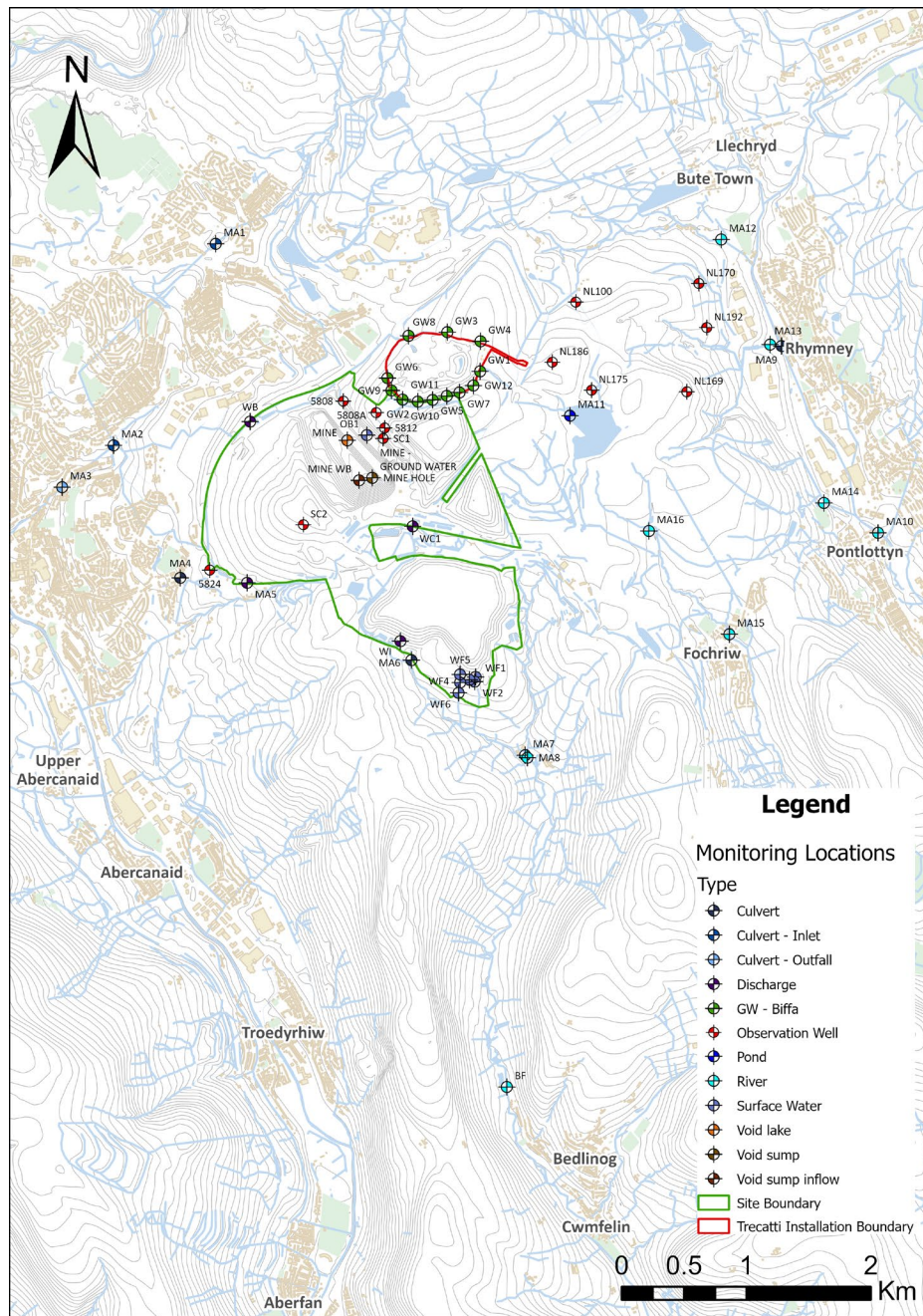
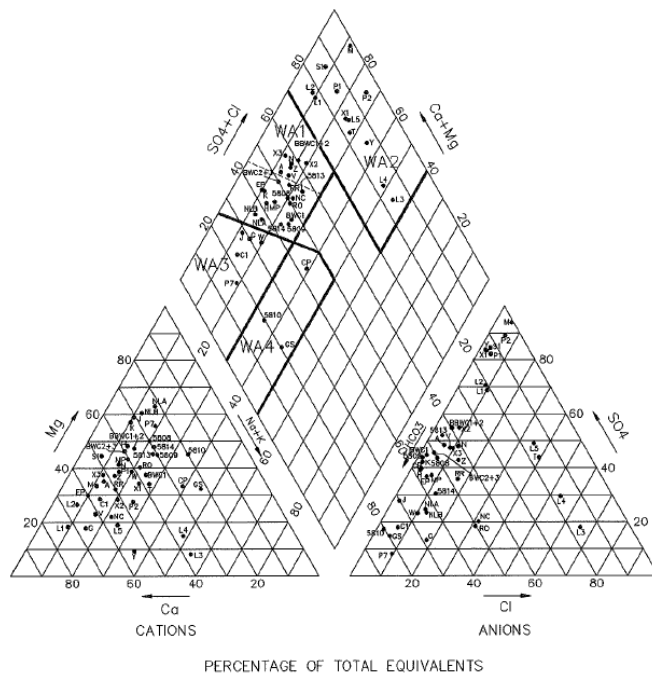


Figure 4 Overview of water quality monitoring locations

Historical water quality is described in the hydrogeology report by Celtic Energy (CEL, 1996). The following points are noted regarding the historical data:

- Based on the Environment Agency General Quality Assessment the Nant Morlais and Nant Cwm Blacs are extensively culverted and poor quality watercourses. The Bargoed Taf, Nant Gyrawd and River Rhymney are good quality watercourses.

- Water quality samples were taken at a number of surface and groundwater locations. Most of the samples were characterised as being Mg-Ca-HCO<sub>3</sub>-SO<sub>4</sub> water types as shown on the piper diagram from the report (Figure 5).
- Surface water samples from the Bargoed Taf and Nant Gyrawd catchments are characterised by high sulfate and low alkalinity concentrations.
- Samples with higher alkalinity concentrations typically originated from areas where water has flowed through various waste materials (landfill, fly tip and mine spoil). Also groundwater further from the site has higher alkalinity.
- Water quality in the mining void and around the workings shows a neutral to slightly alkaline character and electrical conductivity around 1,200 µS/cm.
- A significant proportion of Nant Morlais flow is likely to be mine water flow. A portion of flow to the River Rhymney is also thought to be from the soap workings at Cwmbargoed (just east of OB3).
- A number of samples were taken to assess the extent of contamination from landfill sites in the area, however levels were indicated to be relatively low for monitored organics.



N.B. WA1–WA4 Denotes Water Analysis Groups. (Referred to in text)

Figure 5 Piper diagram based on the water quality data in the 1996 CEL hydrogeology report

With respect to long term water quality monitoring data, the following points provide an overview of the key water quality monitoring trends for the dataset in Appendix C:

- Where long monitoring records are available, such as monitoring at the MA points, the records show for many parameters show little change from monitoring in 2003 to that in the present day.
- The pH recorded in the mine void water body was slightly alkaline with an average of 7.9 and maximum of 8.2. pH in groundwater monitored across the area was relatively similar to the pit void water body, with averages across the dataset analysed of 7.3 and a maximum of 8.7. The average pH at MA05 (one of the regulated discharge points for the site) is 8.1, and average pH was 7.8 at MA06 the outfall located to the south of OB3. The pH in the Nant Morlais is around pH 7.6, and in the Bargoed Taf pH 7.8 (MA08) and Nant Gyrawd pH 7.6 (MA07). The culvert to the Rhymney (MA09) averages pH 7.7. The data therefore suggests that surface and groundwaters at the site are broadly neutral to slightly alkaline with no significant evidence of acidification occurring (having occurred).
- Alkalinity is measured between 200 – 400 mg/l  $\text{CaCO}_3$  in the mine void water (supporting pH data), which is similar to groundwater location 5824 on the western perimeter of the site. Alkalinity in older groundwater monitoring (pre-2017) was typically between 200 – 600 mg/l  $\text{CaCO}_3$ . Alkalinity measured at 5812, just east of the pit void, was around 600 mg/l (2012 – 2017) but since then has increased to around 1,000 mg/l  $\text{CaCO}_3$ . Alkalinity concentrations measured in surface water across the site are positive although generally lower, typically measuring lower than 400 mg/L  $\text{CaCO}_3$ , the measurements are also more variable potentially with reactions to rainfall events and dilution. The culvert monitored at MA6, south of OB3 has an alkalinity average of 215 mg/l  $\text{CaCO}_3$ . Alkalinity measured in the Nant Morlais downstream of potential minewater inflows averages just under 200 mg/L  $\text{CaCO}_3$ .
- Major cations and anions have been monitored across surface and groundwaters. Chloride is typically less than 50 mg/L in most locations, with occasional spikes up towards 100 mg/L. An exception to this is in the groundwater monitoring location 5812 (Figure 6), where chloride rose from around 50 mg/L in 2011 towards around 900 mg/L in 2022. This monitoring location no longer exists. It should be noted that groundwater monitored in similar locations (SC01 and 5808A) did not show such a high concentration, typically less than 100 mg/L although there was a rise in both boreholes. These boreholes are on the north eastern side of the pit void, and closest to the Trecatti landfill site (Section 2.7). The PAV for chloride is 250 mg/L suggesting potential influence of the landfill on groundwater quality.

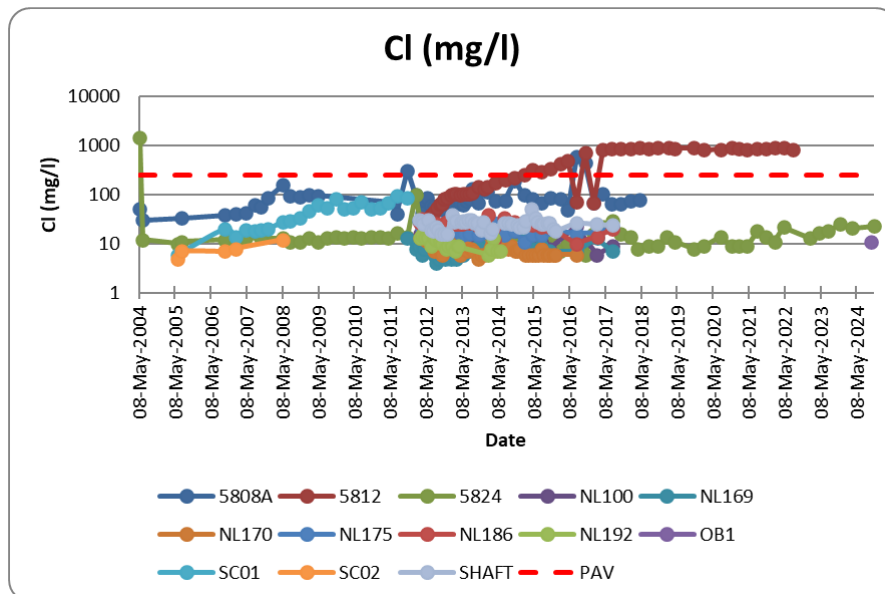


Figure 6 Chloride concentrations over time at groundwater monitoring locations (PAV shown in red dashed line)

- Calcium is typically measured around ~27 mg/L in groundwater locations away from the pit void (5824), and around ~125 mg/L within the pit void (5808). Calcium in surface waters is also typically lower, averaging less than 50 mg/L in locations monitoring rivers. The calcium concentrations along the Nant Morlais have slightly higher, varying between 50 – 150 mg/L, this is likely an effect from the drainage of the pit into this waterbody. The average concentration of calcium at MA06 the outfall south of OB3 is 125 mg/L, and the discharge point at MA05 averages 67 mg/L. The calcium concentration in the Bargoed Taf downgradient of MA06 has an average of 73 mg/L, compared with an average of 50 mg/L for the Nant Gyrawd at MA07. The water chemistry of the mine void shows a similar concentration of calcium to groundwater in that location, and average of ~125 mg/L. Mostly calcium levels are below PAVs.
- The water chemistry tends to follow a similar spatial pattern (i.e. location) with the major ions. Typically groundwater away from the pit void has lower Mg, Na and K (although sometimes variable concentrations of sulfate). The groundwater in the pit void (5812, SC1 and 5808) typically has magnesium of around 80 mg/L, sodium sometimes greater than 500 mg/L (in the case of 5812) and variable sulfate concentrations (mostly below PAVs). Monitoring of the mine void waterbody indicates average concentrations of Mg (100 mg/L), sodium (42 mg/L), potassium (58 mg/L) and sulfate (423 mg/L) which are similar to groundwater monitoring nearby. The monitoring on the Nant Morlais catchment shows some influence from drainage from the mining area, with slightly elevated spikes of Mg and SO<sub>4</sub> (100 – 150 mg/L) when compared to the upstream monitoring. The discharge point at MA05 has slightly elevated (relative to downstream) sulfate, averaging 216 mg/L. The discharge at MA06, below OB3, also has elevated sulfate (averaging 542 mg/L) and magnesium (averaging 100 mg/L) (Figure 7), although a generally decreasing trend over time is observed in the sulfate data.

Monitoring from downstream on the Bargoed Taf indicates elevated sulfate (average 300 mg/L) (Figure 8) and magnesium (between 40 – 100 mg/L) at MA08, in general concentrations have a decreasing trend over time. Sulfate monitoring at MA07 (Nant Gyrawd) shows slightly elevated levels averaging 180 mg/L, but the magnesium concentration at this location is much lower (average 33 mg/L). The monitoring at Rhymney (MA09) shows low concentrations of major ions. It should be noted that some of the major ion parameters at various locations (K, Mg, Na and SO<sub>4</sub>) are at times higher than the PAVs. In some instances where this is a typical occurrence it maybe that the PAVs do not represent the water chemistry across all monitoring locations.

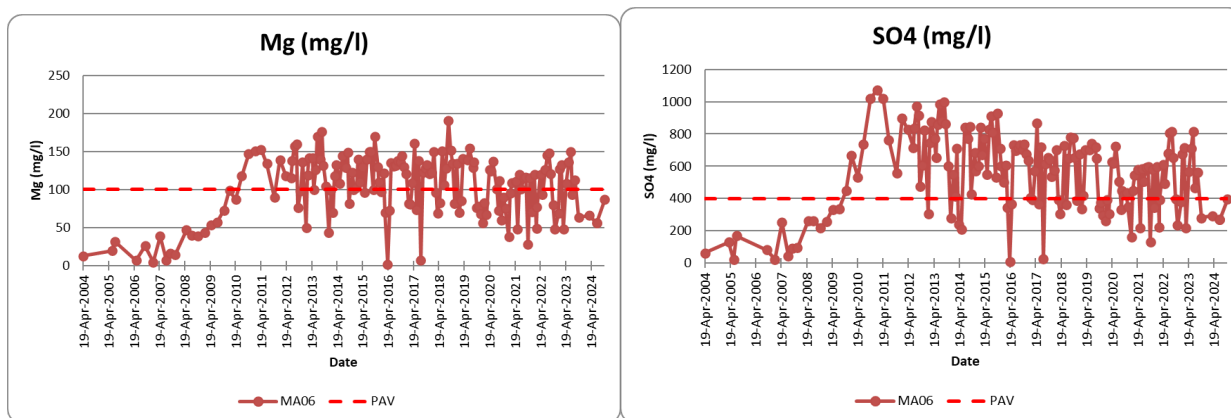


Figure 7 Magnesium and sulfate at MA06 (PAV in red dashed line)

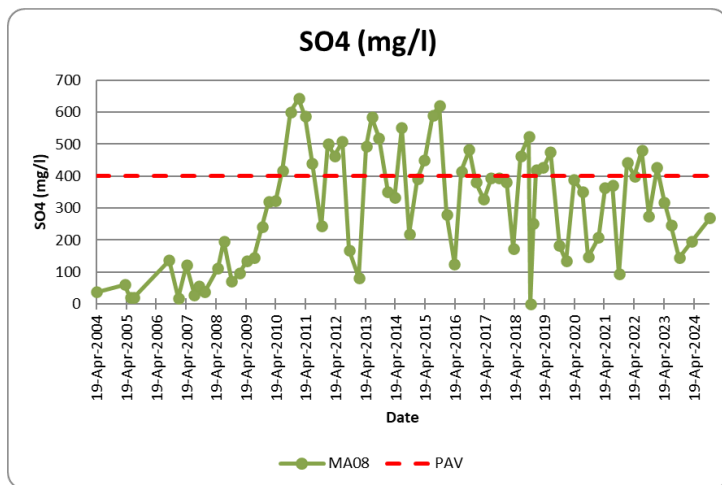


Figure 8 Sulfate at MA08 (PAV in red dashed line)

- Nitrogen (as ammonia) which is reported as ammoniacal nitrogen as N (NH<sub>3</sub>-N) is found above the PAV (0.5 mg/L) at a number of the groundwater monitoring locations (both in pit, downstream and upstream of the pit following rebound of the water level) as seen in Figure 9. The highest of these is at 5812, which is the monitoring location on site closest to the Trecatti landfill site.

It is also measured as an average of 1.2 mg/L in the mine void waterbody. The discharge points at MA05 and MA06 have typical ammonia levels below the 0.5 mg/L PAV, with a few occasional higher concentrations. A similar range of values is noted for surface water monitoring data from the Bargoed Taf, Nant Gyrawd, Nant Morlais and Rhymney. It is noted that the site used explosives (ANFO), which typically contain ammonia, related to excavation within the mine which is a possible source for the observed ammoniacal nitrogen in ground and surface water. However, given the consistent elevated concentrations found in and around the pit, if this was the main source then similar concentrations would also be expected in and around discharges from the overburden and discharge point MA05 from the site, however ammoniacal nitrogen or total N are not as elevated in this location. Total N is noted to be elevated above PAVs in location 5812 and also NL175 and NL169 (both located to the east of the Trecatti landfill site) which may suggest a wider or more diffuse source. The monitoring of ammoniacal nitrogen concentrations in the perimeter wells of the Trecatti landfill site is discussed in Section 2.7, it is noted that the concentration recorded in GW02 the monitoring location just upgradient of the pit void but downgradient of the landfill is found to be steady around 10 mg/L (i.e. suggesting the landfill may represent a source of nitrogen species).

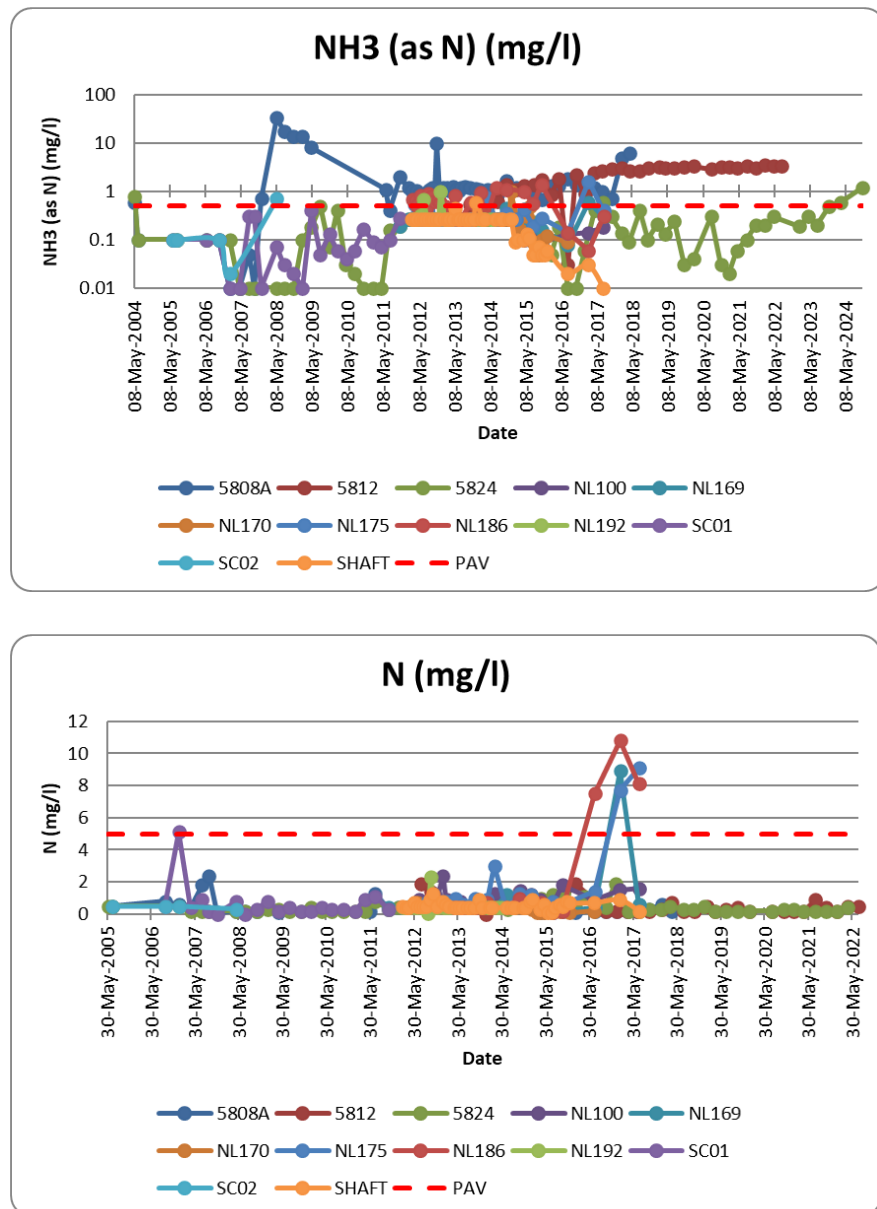


Figure 9 Ammonia as N and total N in groundwater monitoring

- TSS is typically elevated in surface water samples following high rainfall events which are assumed to be causing localised erosion to lead to a higher suspended sediment load. Occasional exceedances above PAVs are noted within the surface water monitoring at various locations including the MA05 and MA06 discharge points, the Bargoed Taf, Nant Gyrawd, Nant Morlais and within the mine void waterbody. It is noted that the majority of data collected was during operational period prior to restoration work, as such given the potential links between TSS and rates of erosion the data is not likely to be representative of conditions post completion of restoration works.

- Exceedances of metals above PAVs are occasionally recorded at a number of locations, a summary of these is below with the full data and graphs in Appendix C:
  - Mn – exceedances recorded in discharges from MA05 and MA06, the mine void, groundwater within the pit area, Nant Morlais, Bargoed Taf, Nant Gyrawd and Rhymney (MA09 and MA10).
  - Se – exceedances recorded in discharges from MA05 and MA06, in pit groundwater and Bargoed Taf and Nant Gyrawd.
  - Fe – exceedances recorded in discharges MA05 and MA06, the mine void, in pit groundwater, groundwater away from the mining area, Bargoed Taf, Nant Gyrawd, Rhymney and Nant Morlais.
  - Al – exceedances recorded in discharges MA05 and MA06, in pit groundwater, Nant Morlais, Bargoed Taf and Nant Gyrawd.
  - Ni – exceedances recorded at discharge MA06, Nant Gyrawd, Rhymney and mine void waterbody
  - Zn – exceedances recorded at discharge MA06, Bargoed Taf and Nant Gyrawd
  - Pb, Cu – occasionally exceeded in some of the groundwater locations away from the pit void
  - As – exceedances recorded in 5812, this is not seen as an exceedance in any other monitoring locations and may be linked to the source of higher ammonia in this location (potentially linked to the landfill site).
  - Groundwater data between 2012 and 2014 show higher levels of a range of metals, however these do not appear to match the trend before or after in the dataset, therefore these exceedances recorded during this period may relate to error(s) in the data set and are not discussed here in detail.

An additional water sample to the standard monitoring routine was included in the October 2024 monitoring round. A one-off sample of surface water runoff into the open pit void from the mine site catchment was sampled and analysed for major ions and metals. The results compared against the PAVs are shown in Table 3, and typically is below most PAV levels. The sample was following a higher rainfall event and is thought to be typical of the wider catchment runoff into the open pit.



Table 3 Pit void runoff inflow October sample

| Analyte                | Units    | Site PAV  | OB1 result |
|------------------------|----------|-----------|------------|
| pH                     | pH units | 6.5 - 8.5 | 8.3        |
| Total Alkalinity       | mg/l     |           | 241        |
| Total Suspended Solids | mg/l     | 50        | <5         |
| Chloride as Cl         | mg/l     | 250       | 11         |
| Aluminium as Al        | mg/l     |           | <0.01      |
| Arsenic as As          | mg/l     | 0.01      | 0.001      |
| Cadmium as Cd          | mg/l     | 0.005     | 0.00002    |
| Calcium as Ca          | mg/l     | 250       | 64         |
| Total Chromium as Cr   | mg/l     | 0.03      | <0.001     |
| Copper as Cu*          | mg/l     | 0.2       | 0.001      |
| Iron as Fe             | mg/l     | 1         | <0.01      |
| Lead as Pb             | mg/l     | 0.1       | <0.0002    |
| Magnesium as Mg        | mg/l     | 100       | 78         |
| Manganese as Mn        | mg/l     | 0.25      | 0.007      |
| Mercury as Hg          | mg/l     | 0.001     | <0.00003   |
| Nickel as Ni           | mg/l     | 0.1       | 0.03       |
| Potassium as K         | mg/l     | 40        | 45         |
| Sodium as Na           | mg/l     | 170       | 10         |
| Total Sulphur as SO4   | mg/l     | 400       | 273        |

| Analyte    | Units | Site PAV | OB1 result |
|------------|-------|----------|------------|
| Zinc as Zn | mg/l  | 0.1      | 0.01       |

## 2.5 Sampling of overburden and backfill

Overburden and backfill samples were taken as part of a site visit by MEM in July 2024 (Appendix B) to validate sampling and analysis results presented in previous assessment carried out. The location of these samples were taken from is shown in Figure 10. A description of the samples is in Table 4. The samples were sent to Geochemic Ltd laboratory for preparation with selected chemical analyses completed by ALS OMAC Laboratories Ltd for metals, sulfur and carbon analysis (full data can be found in Appendix B). A summary of the results from this testing is provided in Table 5, and is nominally compared against UK soil guideline values (SGVs). The acid potential (AP), neutralisation potential (NP) and net potential ratio (NPR) between the AP and NP were all calculated based on the following relationships (GardGuide, 2024):

$$AP \text{ (sulfide S)} = \% \text{sulfS} \times 31.25$$

$$NP \text{ (total C – organic C)} = \%C \text{ (tot – org)} \times 83.3$$

$$NPR = NP/AP$$

The sulfide S was reported from laboratory results to be under 0.2% for the majority of samples, and a maximum of 0.26% which indicates the material is not likely to have high risk of acid generation. Total sulfur is typically the same or very similar to sulfide sulfur, which suggests most sulfur is found as sulfide sulfur and there are little in the way of potential sulfate salts present in the material. Where the sulfide sulfur is slightly higher than 0.1% (OB1~0.2%) the NPR calculated is much greater than three (3) because of significantly higher carbonate carbon content, which suggests that the overall balance between acid and neutralisation potential (acid base accounting) is net neutralising, and as such the material is not likely to be acid generating (and is more likely to be acid consuming). This classification is based on regulatory references, and international guidance (related to AMD) described in Section 1.3.

The definition of Inert Waste as taken from Box 2.2.6 provided in NRW (2014) “*How to comply with your environmental permit. Additional guidance for: mining waste operations*” is provided below:

- The waste will not undergo any significant disintegration or dissolution or other significant change likely to cause any adverse environmental effect or harm to human health;

- The waste has a maximum content of sulphide sulphur of 0.1 %, or the waste has a maximum content of sulphide sulphur of 1 % and the neutralising potential ratio, defined as the ratio between the neutralising potential and the acid potential, and determined on the basis of a static test prEN 15875 is greater than 3;
- The waste presents no risk of self-combustion and will not burn;
- The content of substances potentially harmful to the environment or human health in the waste, and in particular Arsenic, Cadmium, Cobalt, Chromium Copper, Mercury, Molybdenum, Nickel, Lead, Vanadium and Zinc, including in any fine particles alone of the waste, is sufficiently low to be of insignificant human and ecological risk, in both the short and the long term. In order to be considered as sufficiently low to be of insignificant human and ecological risk, the content of these substances should not exceed national threshold values for sites identified as not contaminated or relevant national natural background levels; and
- The waste is substantially free of products used in extraction or processing that could harm the environment or human health.

Based on metal/metalloid concentrations derived from results of compositional analysis, overall the samples likely present a low risk with respect to sensitive receptors (humans/environment) based on comparisons with SGVs. With reference to the regulations and EMMS discussed in Section 1.3 the results support previous analysis and assessment carried out at the site, suggesting that the materials tested would be likely classified as inert waste. Results from the original sampling and analysis described in the EMMS are shown in Table 6. These samples were interpreted to support an inert waste classification with low risk of metal and acid potential from the metals and sulfide contents. The data comparison suggests the baseline characterisation of the material is similar between current sampling and the original sampling used to classify waste and determine material management at Ffos y Fran. As such the results provide a degree of validation of the previous assessment.



Figure 10 Location of overburden, backfill and soil forming material (SFM) validation samples

Table 4 Description of overburden, backfill and SFM validation samples in 2024

| Sample | Location                                                 | Description                                                                                                                                                                                     |
|--------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MS_1   | Backfill material from pit base                          | Grey, silty gravelly clay. Also includes traces of ironstone and fine coal gravels. Friable.                                                                                                    |
| MS_2   | Top of backfill/reclamation area – soil forming material | Dark grey to medium brown clayey gravel, with some ironstone. Mixed mine rocks in surrounding area. Occasional pockets of light brown orangey clay. More gravelly at 15-20 cm depth.            |
| MS_3   | OB1 material                                             | Dark grey silty gravelly clay, also some ironstone present. Ranges to a silty clayey gravel in a nearby location. In surrounding area were friable cobbles and fine gravel sized coal fragments |



| Sample | Location     | Description                                                                                                                                             |
|--------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| MS_4   | OB2 material | Dark brownish grey silty gravel. Friable. Also contains ironstone gravels and occasionally fine gravel sized coal fragments. Occasional pockets of clay |
| MS_5   | OB3 material | Dark grey silty very gravelly clay. Some ironstone present. In surrounding area were cobbles and boulders of mine rocks. Friable.                       |

Table 5 Overburden, backfill and soil forming material chemical analyses

| Parameter      | Unit                      | Soil Guideline Values (SGVs) |           |            | MS_1                       | MS_2                                                     | MS_3  | MS_4  | MS_5  |
|----------------|---------------------------|------------------------------|-----------|------------|----------------------------|----------------------------------------------------------|-------|-------|-------|
|                |                           | Residential                  | Allotment | Commercial | Backfill material pit base | Top of backfill/reclamation area - soil forming material | OB1   | OB2   | OB3   |
| S              | %                         |                              |           |            | 0.07                       | 0.04                                                     | 0.26  | 0.05  | 0.2   |
| Sulphide S     | %                         |                              |           |            | 0.07                       | 0.02                                                     | 0.21  | 0.04  | 0.2   |
| C              | %                         |                              |           |            | 3.77                       | 1.78                                                     | 6.34  | 2.46  | 7.71  |
| C organic      | %                         |                              |           |            | 1.89                       | 1.65                                                     | 5.31  | 2.13  | 6.26  |
| pH             | s.u.                      |                              |           |            | 7.7                        | 6.4                                                      | 6.1   | 7.5   | 6.2   |
| As             | ppm                       | 32                           | 43        | 640        | 10.6                       | 8.2                                                      | 12.8  | 6.7   | 10    |
| Hg             | ppm                       | 1                            | 26        | 26         | 0.054                      | 0.045                                                    | 0.071 | 0.047 | 0.108 |
| Sb             | ppm                       |                              |           |            | 1.66                       | 0.66                                                     | 0.61  | 0.57  | 0.56  |
| Se             | ppm                       | 350                          | 120       | 13000      | 0.3                        | 0.8                                                      | 0.6   | 0.3   | 0.7   |
| Cd             | ppm                       | 10                           | 1.8       | 230        | 0.16                       | 0.2                                                      | 0.14  | 0.17  | 0.1   |
| Co             | ppm                       |                              |           |            | 18                         | 21.1                                                     | 21.2  | 18.8  | 16.5  |
| Cu             | ppm                       |                              |           |            | 30.4                       | 49.5                                                     | 39.2  | 38.7  | 47.4  |
| Mo             | ppm                       |                              |           |            | 0.98                       | 1.1                                                      | 1.18  | 0.99  | 1.28  |
| Ni             | ppm                       | 130                          | 230       | 1800       | 49.6                       | 61.3                                                     | 61.2  | 54.2  | 54.2  |
| Pb             | ppm                       |                              |           |            | 22.3                       | 28.4                                                     | 25.5  | 23.4  | 27    |
| Zn             | ppm                       |                              |           |            | 97                         | 122                                                      | 116   | 110   | 78    |
| Acid potential | (kg CaCO <sub>3</sub> /t) |                              |           |            | 2                          | 1                                                        | 7     | 1     | 6     |



| Parameter                   | Unit                      | Soil Guideline Values (SGVs) |           |            | MS_1                       | MS_2                                                     | MS_3 | MS_4 | MS_5 |
|-----------------------------|---------------------------|------------------------------|-----------|------------|----------------------------|----------------------------------------------------------|------|------|------|
|                             |                           | Residential                  | Allotment | Commercial | Backfill material pit base | Top of backfill/reclamation area - soil forming material | OB1  | OB2  | OB3  |
| Neutralising potential (NP) | (kg CaCO <sub>3</sub> /t) |                              |           |            | 157                        | 11                                                       | 86   | 27   | 121  |
| Net potential ratio (NPR)   | -                         |                              |           |            | 72                         | 17                                                       | 13   | 22   | 19   |

Table 6 Miller Argent EMMS overburden samples

| Parameter    | Unit  | SGV Residential | SGV Allotment | SGV Commercial | OB1 SOOB1 A | OB1 SOOB1 B | OB2 SOOB2 A | OB2 SOOB2 B | OB3 SOOB3 A | OB3 SOOB3 B |
|--------------|-------|-----------------|---------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Total sulfur | %     |                 |               |                | 0.147       | 0.184       | 0.146       | 0.142       | 0.159       | 0.2         |
| Sulfide as S | mg/kg |                 |               |                | <0.5        | <0.5        | <0.5        | <0.5        | <0.5        | <0.5        |
| pH           | s.u.  |                 |               |                | 7.4         | 7.5         | 7.7         | 8           | 7.7         | 7.2         |
| Arsenic      | mg/kg | 32              | 43            | 640            | 4.3         | 8.9         | 7.1         | 5.2         | 4.6         | 10.9        |
| Cadmium      | mg/kg | 10              | 1.8           | 230            | 0.21        | 0.21        | 0.19        | 0.18        | 0.16        | 0.25        |
| Chromium     | mg/kg |                 |               |                | 10.1        | 13.6        | 11.6        | 16.3        | 5.1         | 6.3         |
| Cobalt       | mg/kg |                 |               |                | 16.9        | 16          | 16          | 18.2        | 13.2        | 20          |
| Copper       | mg/kg |                 |               |                | 34.8        | 36.2        | 47.4        | 35          | 36.1        | 53.1        |
| Lead         | mg/kg |                 |               |                | 19.2        | 17.8        | 19          | 18.1        | 18.1        | 28.3        |
| Mercury      | mg/kg | 1               | 26            | 26             | <0.1        | <0.1        | <0.1        | <0.1        | <0.1        | 0.21        |
| Molybdenum   | mg/kg |                 |               |                | 0.5         | 0.8         | 0.9         | 0.6         | 0.8         | 1.3         |
| Nickel       | mg/kg | 130             | 230           | 1800           | 37.5        | 42          | 37.9        | 40.4        | 31.9        | 58.5        |
| Vanadium     | mg/kg |                 |               |                | 15.7        | 21.9        | 16.9        | 21.6        | 26.5        | 22.1        |
| Zinc         | mg/kg |                 |               |                | 83.2        | 79.6        | 91.1        | 83.5        | 66.6        | 129         |

## 2.6 OB3 seepages and monitoring

It was noted during the site visit (and on satellite photos) that there is an area of orange (iron) staining at an overflow pipe south of OB3 (MA06), and also in and around the settling ponds to the south of OB3. It is understood that the lagoon system (WF) south of OB3, originally had an attenuation pond that leads to four settling ponds. The footprint of OB3 eventually grew to cover this attenuation pond. Since then, a new pond/sump has been 'dug out' to act as a collection pond for toe seepage (Figure 11), close to the original attenuation pond, that drains to the four settling ponds. The pond contains current runoff or seepage from OB3, and possibly discharge from underlying workings. The pond does not show any visible orange staining.



*Figure 11 Pond at the toe of OB3.*

Within the settling ponds below this OB3 toe pond, orange staining was present (suggestive of precipitation of secondary iron bearing minerals). It was mainly seen at the northern end of the ponds (closest to OB3/attenuation pond) (Figure 12), with a higher concentration of staining present close to a leaking Penstock valve (inlet) (Figure 13). This Penstock valve originally fed the sediment ponds from the attenuation pond. The water from these settling ponds is discharged directly into the environment (outlet).



*Figure 12 Sediment ponds showing orange staining at northern end.*



*Figure 13 Concentration of orange staining around leaking Penstock valve.*

Outside of the boundary of the settling ponds, a culvert with heavy orange staining was located (Figure 14), it is understood that this may have been the original attenuation overflow culvert.



*Figure 14 Culvert with orange staining*

After the site visit was completed by MEM, MSW undertook additional water sampling in this area based on suggestions from MEM, at the following locations indicated in Figure 15. The monitoring locations are also shown in Figure 4. Analysis of samples collected from monitoring included pH and major ions to allow identification of water type and comment on the characteristics of the source of the water, as well as a suite of metals/metalloids analysis to assess potential metalliferous drainage risk. The results of two sampling rounds are shown in Table 7 and the data included in Appendix C. Results indicate that magnesium, potassium and sulfate are elevated (which are also elevated at MA7 and MA8) and are found above PAVs in all of the samples. Iron and manganese are elevated in two and three samples respectively, but are not elevated in the outfall from the settling ponds to the stream or at the downstream monitoring locations. This data collectively suggests that the settling ponds are currently working effectively to reduce residual metal loads (iron and manganese) from OB3 seepage prior to discharge (but has less effect on sulfate, magnesium and potassium). The outfall (WF5) has a small area of wetland/boggy ground just below the outfall location which may also be helping to further attenuate metals in solution close to the outfall area.



Figure 15 Additional indicative sample locations around southern edge OB3

Table 7 Summary of results of monitoring around southern OB3 drainage

| Analyte                | Units                  | Site PA V | WF1<br>Pond from under OB3 | WF2<br>Inlet to Pond No4 | WF3<br>Inlet to Pond no.3 | WF4<br>Culvert outfall from settling ponds to stream | WF5<br>Culvert outfall from overflow pipe beneath OB3 | WF6<br>Flow downstream of points 4 and 5 |
|------------------------|------------------------|-----------|----------------------------|--------------------------|---------------------------|------------------------------------------------------|-------------------------------------------------------|------------------------------------------|
| Sample date            |                        |           | 02/10/2024                 | 02/10/2024               | 02/10/2024                | 02/10/2024 30/10/2024                                | 02/10/2024 30/10/2024                                 | 02/10/2024 30/10/2024                    |
| pH                     | pH units               | 6.5 - 8.5 | 8                          | 8.1                      | 6.8                       | 8.3 8.2                                              | 7.2 7                                                 | 8.3 8.2                                  |
| Total Alkalinity       | mg/l CaCO <sub>3</sub> |           | 186                        | 216                      | 222                       | 198 186                                              | 316 330                                               | 237 239                                  |
| Total Suspended Solids | mg/l                   | 50        | 23                         | 13                       | 44                        | 11 <5                                                | 11 10                                                 | 13 <5                                    |
| Chloride as Cl         | mg/l                   | 250       | 2                          | 2                        | 3                         | 3 4                                                  | 2 5                                                   | 3 4                                      |



| Analyte              | Units | Site<br>PAV | WF1                          | WF2                     | WF3                      | WF4                                                 |          | WF5                                                     |          | WF6                                     |          |
|----------------------|-------|-------------|------------------------------|-------------------------|--------------------------|-----------------------------------------------------|----------|---------------------------------------------------------|----------|-----------------------------------------|----------|
|                      |       |             | Pond<br>from<br>under<br>OB3 | Inlet to<br>Pond<br>No4 | Inlet to<br>Pond<br>no.3 | Culvert outfall<br>from settling<br>ponds to stream |          | Culvert outfall<br>from overflow<br>pipe beneath<br>OB3 |          | Flow<br>downstream of<br>points 4 and 5 |          |
| Aluminium as Al      | mg/l  | 0.5         | 0.01                         |                         | <0.01                    | <0.01                                               | <0.01    | <0.01                                                   | <0.01    | 0.01                                    | <0.01    |
| Arsenic as As        | mg/l  | 0.01        | <0.001                       |                         | <0.001                   | <0.001                                              | <0.001   | <0.001                                                  | <0.001   | <0.001                                  | <0.001   |
| Cadmium as Cd        | mg/l  | 0.005       | <0.0002                      |                         | <0.0002                  | <0.0002                                             | <0.0002  | 0.00003                                                 | <0.0002  | <0.0002                                 | <0.0002  |
| Calcium as Ca        | mg/l  | 250         | 68                           | 90                      | 163                      | 92                                                  | 93       | 133                                                     | 157      | 107                                     | 125      |
| Total Chromium as Cr | mg/l  | 0.03        | 0.002                        |                         | 0.01                     | <0.001                                              | <0.001   | 0.004                                                   | <0.001   | 0.003                                   | <0.001   |
| Copper as Cu         | mg/l  | 0.2         | 0.001                        |                         | <0.001                   | <0.001                                              | <0.001   | <0.001                                                  | <0.001   | <0.001                                  | <0.001   |
| Iron as Fe           | mg/l  | 1           | <0.01                        | 0.03                    | 21.7                     | 0.02                                                | 0.02     | 3.55                                                    | <0.01    | <0.01                                   | <0.01    |
| Lead as Pb           | mg/l  | 0.1         | <0.0002                      |                         | <0.0002                  | <0.0002                                             | <0.0002  | 0.0002                                                  | <0.0002  | <0.0002                                 | <0.0002  |
| Magnesium as Mg      | mg/l  | 100         | 97                           | 125                     | 193                      | 127                                                 | 126      | 154                                                     | 166      | 130                                     | 145      |
| Manganese as Mn      | mg/l  | 0.25        | 0.073                        |                         | 3.56                     | 0.04                                                | 0.04     | 1.24                                                    | 1.1      | 0.096                                   | 0.035    |
| Mercury as Hg        | mg/l  | 0.001       | <0.00003                     |                         | <0.00003                 | <0.00003                                            | <0.00003 | <0.00003                                                | <0.00003 | <0.00003                                | <0.00003 |
| Nickel as Ni         | mg/l  | 0.1         | 0.007                        |                         | 0.06                     | 0.003                                               | 0.002    | 0.042                                                   | 0.029    | 0.008                                   | 0.005    |
| Potassium as K       | mg/l  | 40          | 35                           | 43                      | 48                       | 41                                                  | 38       | 53                                                      | 50       | 44                                      | 46       |
| Sodium as Na         | mg/l  | 170         | 9                            | 13                      | 23                       | 14                                                  | 12       | 16                                                      | 20       | 14                                      | 58       |
| Total Sulphur as SO4 | mg/l  | 400         | 423                          | 585                     | 1090                     | 610                                                 | 615      | 716                                                     | 832      | 614                                     | 717      |
| Zinc as Zn           | mg/l  | 0.1         | 0.027                        |                         | 0.062                    | 0.012                                               | 0.004    | 0.031                                                   | 0.009    | 0.013                                   | 0.005    |

## 2.7 Trecatti Landfill site

The Trecatti landfill site is operated by Biffa and located to the north east of the Ffos-y-Fran site. A conceptual report by ESI on behalf of Biffa in 2011 for the site states that groundwater monitoring is recorded quarterly at perimeter boreholes. The site was partially backfilled with mine spoil prior to commencement of the landfill operation. Groundwater flow is complex in the wider area, due to the mine workings and DFDS, however groundwater flow is typically towards the south west towards the Ffos-y-Fran mine void (ESI, 2011). It is understood that the landfill has been lined and leachate is typically collected however it is also understood an earlier area of waste was placed prior to liner installation (ESI, 2011).

A number of data requests and approaches were made by MSW to Biffa request monitoring records from the site during 2024 however no records were ever supplied. Open access data, from annual and quarterly reports, was downloaded from the NRW data retrieval service in October 2024. The reports provided monitoring data for perimeter boreholes around the site. The groundwater monitoring data retrieved from the open access site has been added to the water quality database. Data available from 2024 back to 2021 has been included. Data was available for 6 monitoring locations. Monitoring at the site appears to be quarterly for a range of parameters. Data has been compared against the Ffos-y-Fran PAVs for reference.

The average pH across the Trecatti borehole data set is 7.4, and alkalinity around 600 mg/l  $\text{CaCO}_3$ . The major ion chemistry is missing sulfate analyses. Calcium averages 151 mg/L, magnesium 122 mg/L, potassium 75 mg/L, sodium 100 mg/L and chloride 227 mg/L across all the boreholes. Maximum concentrations tend to be higher than these averages for and linked to specific boreholes, for potassium GW02, for Ca, Na and Cl GW08 and for Mg GW04. Chloride (Figure 16) measured in groundwater in and around the pit void is typically lower, and this is similar for other major ions such as potassium and sodium, suggesting groundwater migrating from the Trecatti site has a distinctly different geochemical profile.

Ammonia (Figure 17) reported as ammoniacal Nitrogen as N measured in the perimeter boreholes is elevated above the PAVs for Ffos-y-Fran. It is highest (over 10 mg/L) in GW02 which is the borehole closest to the pit void. Monitoring data available for metals tends to show relatively low concentrations, however iron occasionally shows spikes above the Ffos-y-Fran PAVs (Figure 18). Zinc (Figure 19) is also elevated above the PAVs at a number of locations, in particular at GW02 where the concentrations is over 2.5 mg/L. The records available for mecoprop and tritium (Figure 20 and Figure 21) include earlier data (2010 – 2013) which was included in Ffos-y-Fran's water quality monitoring data. This is because there was perceived to be a risk of contamination during conversations with NRW regarding monitoring. Current concentrations of mecoprop appear to be lower, however tritium is still slightly elevated in GW02. Exceedance of some trigger levels (mecoprop and ammonia) at downgradient boreholes (GW02) were found as early as 2007 (ESI, 2011). The compliance limit for GW2 ammoniacal nitrogen is stated as 1.5 mg/L, 250 mg/L for Cl and 0.04 ug/L for mecoprop in the 2011 report.

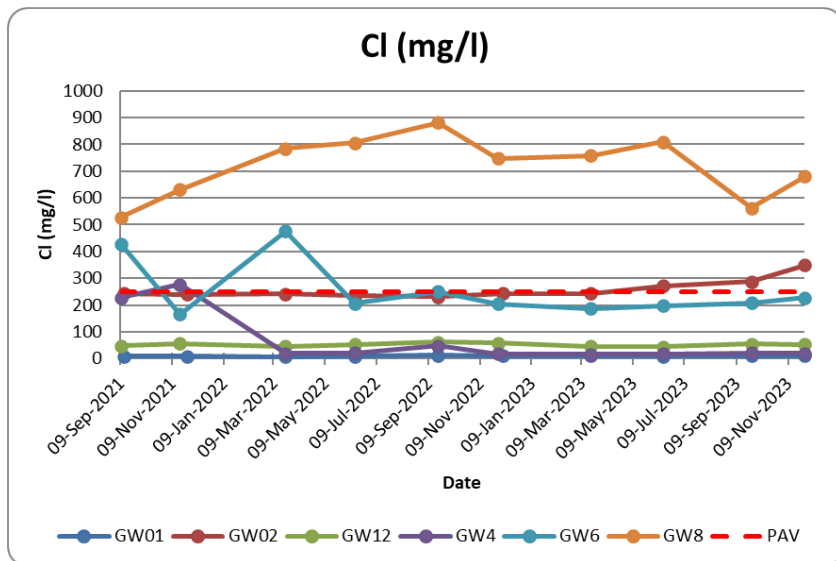


Figure 16 Chloride monitoring in Trecatti landfill perimeter boreholes

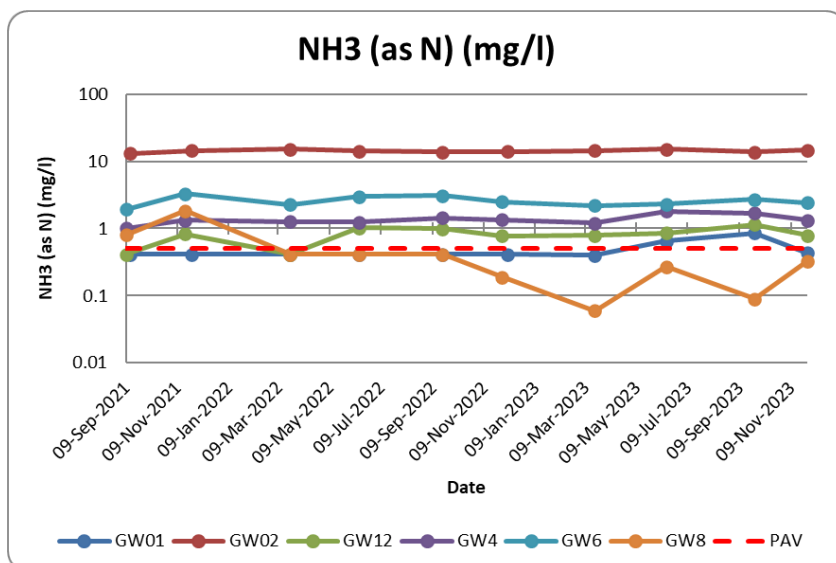


Figure 17 Ammoniacal Nitrogen as N monitoring in Trecatti landfill perimeter boreholes

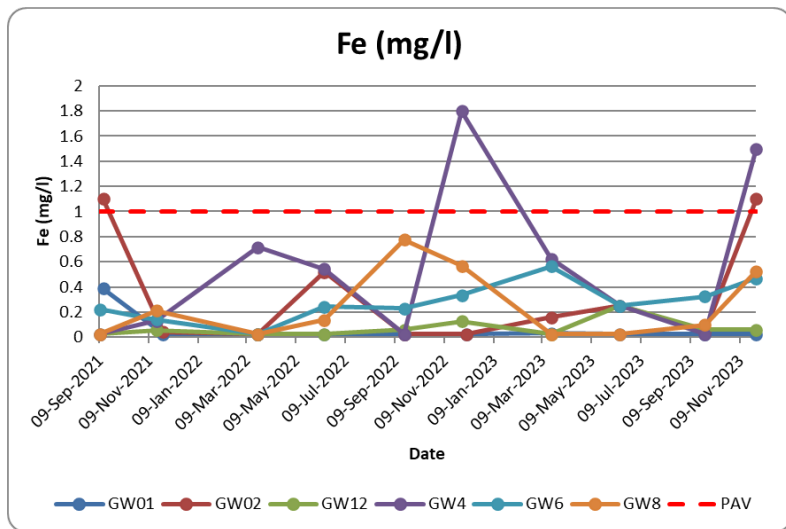


Figure 18 Iron monitoring in Trecatti landfill perimeter boreholes

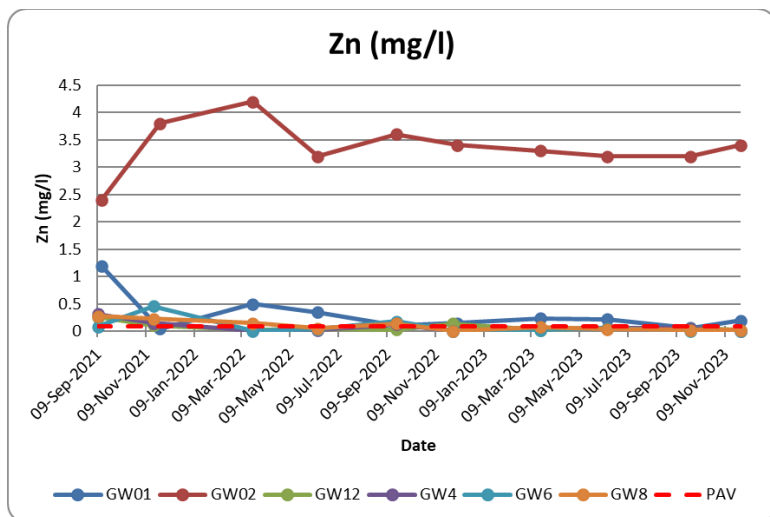


Figure 19 Zinc monitoring in Trecatti perimeter boreholes

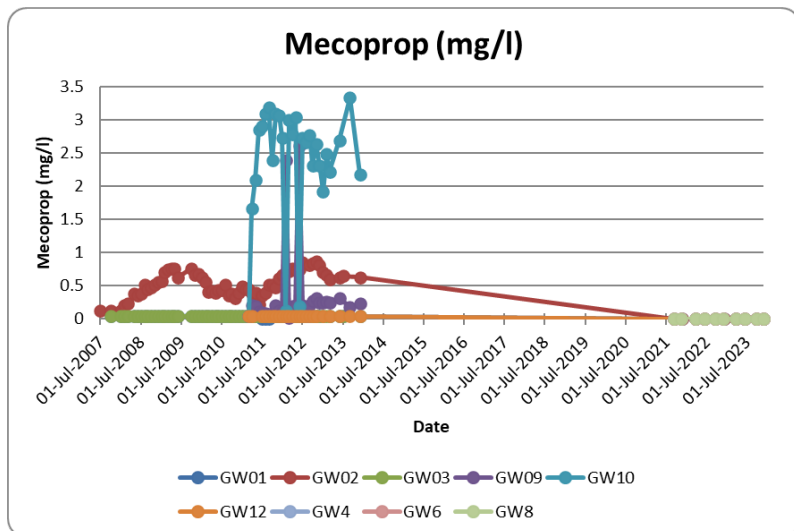


Figure 20 Mecoprop monitoring in Trecatti landfill perimeter boreholes

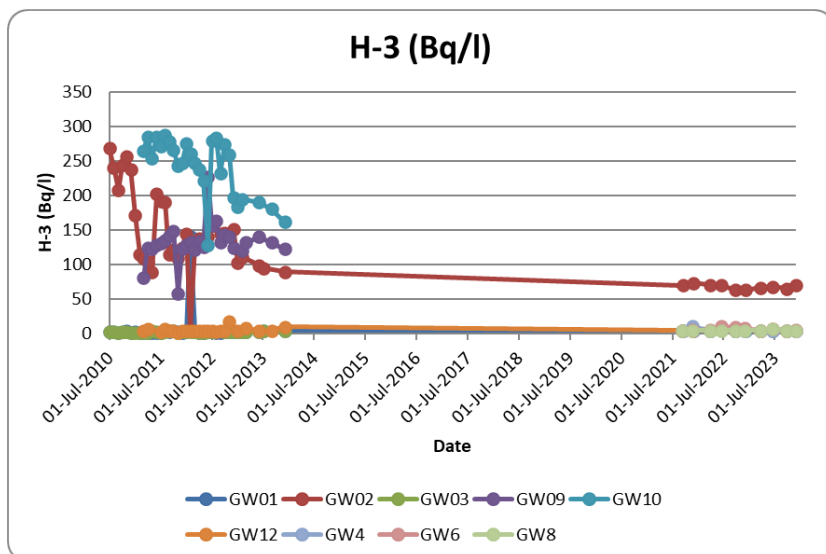


Figure 21 Tritium monitoring in Trecatti landfill perimeter boreholes

### 3 CONCEPTUAL MODEL

#### 3.1 Sources

The key water quality risks related to the time period following the completion of the restoration scheme relate to those current sources which will remain a significant source following restoration. Consideration is also made of background or offsite sources, for example nitrogen compounds. Since the presence of nitrogen compounds relate to sources that were only used during operations (i.e. no ongoing additional source post cessation of operations) it is likely these were (are) relatively quickly flushed from the system, and represent a declining source (i.e. no ongoing contribution). However for nitrogen, it should also be considered that other (background) sources in the surrounding land area, such as the Trecatti landfill and also grazing pasture are also likely to be a significant source of nitrogen (i.e. offsite/background sources are likely to be dominant in post restoration completion).

This assessment focuses on the key risks from acid and metalliferous drainage related to implementation and long term management of the restoration scheme, which essentially include any risks remaining (i.e. residual risk) from key sources which include overburden, backfill or exposed pit walls. Offsite or residual (pre-existing) sources are not included since these are not addressed specifically by the restoration scheme.

The following sources are considered within the assessment:

- Overburden areas - the material placed in these areas can be considered as a relatively low risk AMD source on the basis that it has previously been classified as inert which is supported by additional sampling of the material carried out as part of this assessment. However, given the significant volume and nature of the material (mine waste), and findings of surface water quality monitoring from the site, the materials currently stored within the overburden areas will be assessed as potential sources of poor quality water for conservatism for the purposes of this assessment.
- Overburden areas – localised point sources. Following site inspection and subsequent laboratory analysis of water samples, an area of poorer quality drainage discharge to surface water was located to the south of OB3 related to point source discharge. An assessment of this drainage is included as a potential source of impacted quality water post-restoration.
- Pit void waterbody – following cessation of mining a waterbody has already formed within the pit void and it is expected (based on finding of hydrogeological assessment) that this will become a permanent feature (i.e. will remain once restoration has been completed). Based on review of existing water quality of water within the pit void (samples taken from the pit void water body) and surrounding groundwater, it is assumed the water body within the pit void is a potential source of impacted quality water.

The backfill that has been placed within the pit is considered mostly low risk (based on previous material classification and more recent testing completed to date) and it is placed mostly downgradient relative to groundwater flow direction and orientation of the pit void so unlikely to be a major chemical load contributor to the overall water quality of the pit void water body. Runoff from the pit walls and groundwater inflow may potentially be a source of impacted quality water and as such will be included within the pit void water body assessment.

### 3.2 Pathways

The major pathways for the movement of impacted quality water towards receptor locations is within existing proposed surface and groundwater drainage flow paths. These are more fully described in hydrology and hydrogeology sections of the ES and the surface water network is shown on Figure 4. The following are the key pathways considered during the assessment:

- The pit void water body is considered as a pathway as well as a source since this is considered in the hydrogeological assessment as a “flow through” style pit lake
- Groundwater flow to the south and west based on the main flow path in the groundwater body
- Groundwater flow via old workings and the Dowlais Free Drainage System (DFDS)
- Surface water flow as the following:
  - Discharges from the DFDS into the Nant Morlais catchment
  - Discharges from the DFDS into the River Rhymney
  - Discharges from overburden areas into neighbouring surface waterbodies
  - Discharges from existing OB3 seepage and outfall area to the Bargoed Taff
  - Discharge from groundwater into the River Taff from the pit void

### 3.3 Receptors (source pathway receptor linkages)

Potential receptors were screened as part of the assessment and specific receptors/locations have been considered for effects analysis:

- Current locations which are monitored or designated as permitted discharge points based on the likely pathways for the sources identified, including the following:
  - Bargoed Taf waterbody downstream of OB3
  - Groundwater monitoring point at 5824 – the groundwater point likely in the downgradient flowpath of the pit void waterbody as the groundwater leaves the property boundary
- Potential ecological receptors (internationally or nationally recognised) are all outside of the 3 km assessment boundary, as such these locations are screened out of the assessment.
- Water abstractions and supplies within the 3 km assessment area and downstream or downgradient of the potential sources are as follows (grid coordinates are not provided due to privacy requirements):

- 1 surface water abstraction licence relating to abstraction for angling from the River Rhymney (21/57/11/0001).
- 2 licences associated with surface water abstraction for angling from the Taf Bargoed (21/57/22/0032 and WA/057/0021/001)
- WFD classified surface water and groundwater bodies as outlined in Table 8.
- The pit void water body is considered as simultaneously a source and a pathway and so is not exclusively considered as a receptor. Post restoration water quality objectives have not been defined (at the time of writing) for this water body and as such existing PAVs are used as indicative values to assess potential impacts to the water body (when considered as a receptor).

Table 8 WFD waterbodies within the 3 km assessment zone

| WFD water body                                                   | WFD classification | Overall rating | Chemical rating                       | Reasons for not achieving status    |
|------------------------------------------------------------------|--------------------|----------------|---------------------------------------|-------------------------------------|
| Taff – confluence with Taf Fechan to confluence with River Cynon | River              | Moderate       | High                                  | Mit_Assmnt                          |
| River Rhymney - source to confluence with Nant Bargod Rhymni     | River              | Moderate       | High                                  | Fish                                |
| Nant Morlais - source to confluence with River Taff              | River              | Moderate       | High                                  | NH3; Mit_Assmnt                     |
| Nant Bargod Rhymni - source to confluence with River Rhymney     | River              | Poor           | High                                  | Fish                                |
| Taff Bargoed                                                     | River              | Moderate       | High                                  | Mit_Assmnt                          |
| Taf Fechan - source to conf Afon Taf Fawr                        | River              | Moderate       | High                                  | Mit_Assmnt                          |
| SE Valleys Carboniferous Limestone                               | Groundwater        | Good           | Good                                  |                                     |
| SE Valleys Carboniferous Coal Measures                           | Groundwater        | Poor           | Poor to Good (dependent on indicator) | Groundwater/surface water chemistry |

## 4 AMD ASSESSMENT

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### 4.1 Overburden

Samples of overburden, backfill and soil forming material have been subject to sampling and laboratory analysis during the 2024 assessment and as part of the EMMS. Interpretation of the results of analyses on samples taken from both studies are in broad agreement and suggest that the waste material would be typically considered as inert waste (based on NPR, sulfide content and metals content) and is therefore classified as relatively low risk with respect to the potential for generating significant acid and metalliferous drainage impacts (Section 2.5).

As described in the site visit and subsequent sampling and analysis seepages, the settling pond at the south of OB3 shows a discrete area of secondary iron mineral precipitation (considered to be evidence for formation of secondary iron hydroxides) below an outfall pipe and around the settling ponds. Given the formation of iron hydroxides in seepage discharge is a typical indicator of potential AMD further investigation was undertaken including a number of water quality samples in and around the settling ponds and outfalls. These are described in Section 2.6. Based on results of the investigation carried out this area is identified as a potential point source of poorer quality water to the receiving environment. Because of the limited nature of the investigation carried out the source of the water that comprises this point source discharge was not established, as such it is not possible to determine if restoration would have any significant impact on future water quality. As such for conservatism it is assumed for the purposes of this assessment that this point source will remain in a similar condition post restoration. No other areas of significant concern were identified during the site visits, review of the monitoring data and studies of satellite images of the overburden areas.

The water samples taken at the seepages and surface water within settling ponds south of OB3 have been assessed using a geochemical charting technique (piper diagram) shown in Figure 22. The diagram also compares typical groundwater data from 5824, SC1, NL175 and NL186, as well as surface water data from MA7 and MA8. The piper diagram allows an assessment of the type of water that each sample represents by comparing the proportions of different major ions. Overall the seepages from OB3 and the settling pond appear to show Ca-Mg-SO<sub>4</sub> dominated water, with a lesser influence from Na-K-HCO<sub>3</sub>. The downstream surface water is also very similar to the OB3 location, typically a similar water type. The groundwater is dominated by HCO<sub>3</sub>, but is a mix of Ca-Mg, and even slightly trending towards Na-K in one instance. This suggests that the seepages are distinct geochemically from the underlying groundwater. It is assumed that the groundwater locations included in the assessment would potentially be influenced by historical underground workings and mining on the site, so it would suggest that the source of water in the OB3 seepages is potentially not linked to a deeper source.



The spread of data and groups of water types indicated on the recent monitoring in Figure 22 is very similar to the water types presented in Figure 5, which is based on a 1996 assessment. As such, the main characteristics of the surface and ground water at the site appears to be very similar to pre-operations (pre-2003).

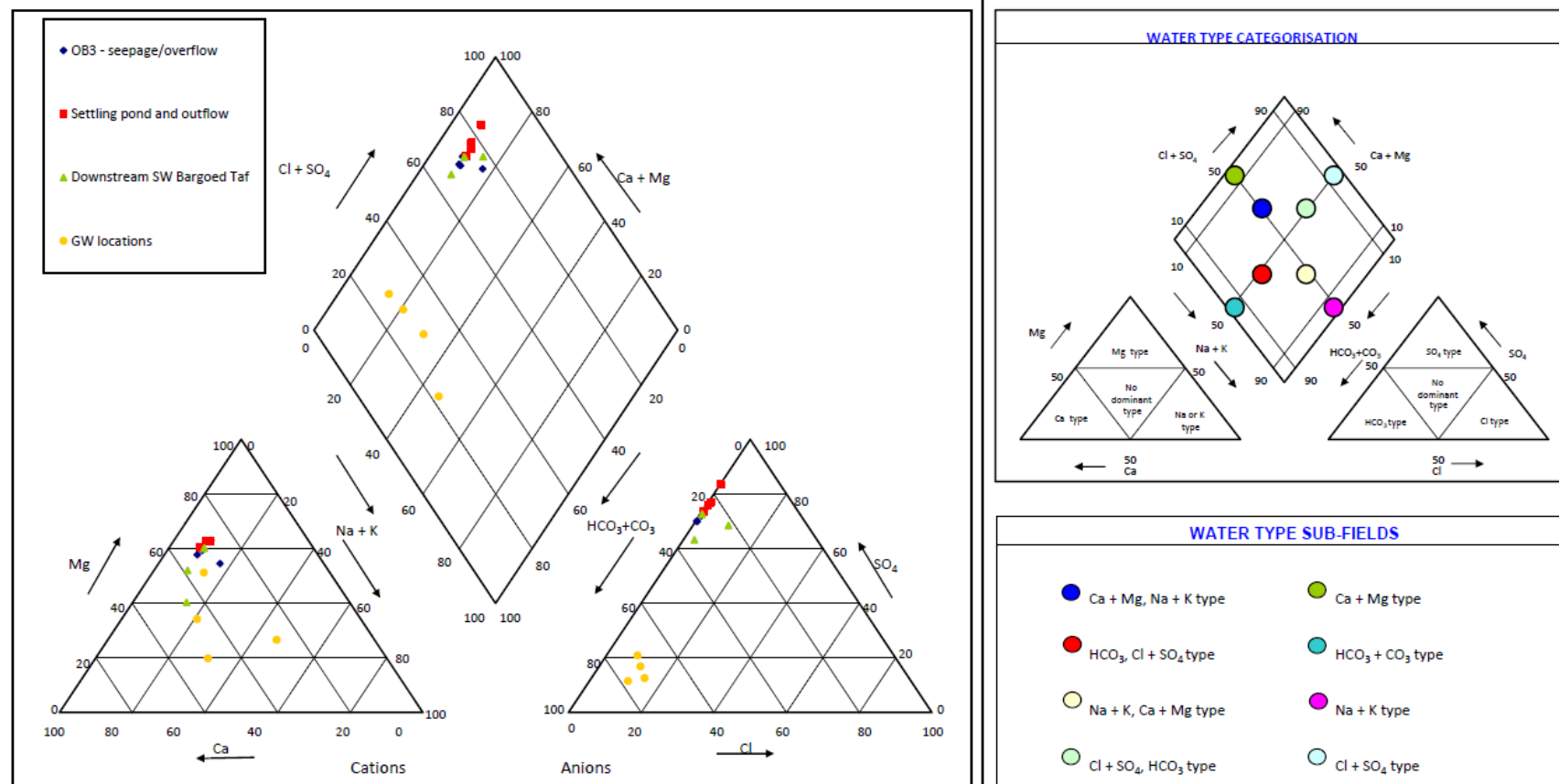


Figure 22 Piper diagram comparing samples around OB3 seepages and settling ponds with groundwater and downstream surface water

The risk relating to metal/metalloid species for the drainage south of OB3 is described in the monitoring data presented in Section 2.6. Surface water quality sampling and analysis indicate manganese, iron as well as magnesium, sulfate and potassium are elevated (relative to adopted assessment criteria) in some of the drainage from around MA6 and the settling ponds to the south of OB3. Based on assessment of reviewed water quality data the settling ponds appear to be (and have) mitigating metalliferous drainage impacts from the southern portion of OB3, reducing the metal loads so that concentrations in downstream surface water monitoring locations are below the site guided PAVs. Water quality data suggests that the outfall around MA6 is diluted such that downstream in the Bargoed Taf watercourse much of the metal load is reduced so concentrations in surface water are at more acceptable levels (presumably as a result of dilution).

Surface water quality monitoring data from around OB3 and the Bargoed Taf indicates the same or similar geochemical composition and thus metalliferous drainage risk profile since around 2011 (see Appendix C). An ecological assessment was completed in the Bargoed Taf watercourse in 2014 and 2015 by Aquilina Environmental Quality (Aquilina, 2014 and 2015) to assess the impact of water quality from discharges from the Ffos y Fran reclamation scheme on the watercourse and aquatic macroinvertebrates as the indicator organisms. Six sample locations were used for the assessment in 2014 and seven in 2015 including ones at or close to the monitoring points WI, MA6, MA7 (2015 only) and MA8. Based on the ecological assessment the monitoring points identified were assigned as good biological quality for the waterbody and discharges from the site in this area were assessed as having minimal impact to the waterbody. In 2015 one sample site (Nant Gyrawd control site (MA7)) was classified as very good biological quality. One site on the Bargoed Taf between the OB3 settlement pond outfalls and the downstream monitoring location at MA8 had a very good score for part of the 2015 assessment, the latter had improved from good to very good between the 2014 and 2015 assessment. It was noted that regular removal of silt build up at WI may have resulted in a lower biological diversity as it reduced in channel vegetation and biological disturbance. Following cessation of mining, sediment removal activities will decrease or stop, as such based on these observations the biological score may increase in the future with this respect.

The estimated interflow (discharge from the overburden areas) to surface water, runoff (as discharge to surface water) and recharge to groundwater (through the overburden areas) is presented in Table 9. The numbers presented are for pre-restoration (assuming bare soil as the baseline) and post-restoration (assuming vegetation cover has been reestablished across the whole areas). The pre-restoration estimate is slightly conservative, as there are already some established areas of vegetation on the overburden, particularly OB2, however these areas are still relatively recently established and are not likely to fully act like a revegetated landcover. The estimated volumes are based on the SWAc recharge models used to set-up the groundwater model for the site (Groundwater Science, 2024). The methodology is more fully described in this report. The overall discharge to surface water from the overburden areas is a combination of interflow and runoff. Runoff and interflow from most of OB1 is likely to report to the pit void waterbody. Runoff and interflow from OB2 and OB3 will mostly report to the Bargoed Taf and Nant Gyrawd watercourses. Groundwater flow (Groundwater Science, 2024) is typically to the south, so a portion of the recharge from the overburden areas is likely to be recharging towards the Bargoed Taf watercourses.

Table 9 Estimated recharge to surface water, groundwater and runoff in overburden areas

| Overburden area | Area (km <sup>2</sup> ) | Pre-restoration (bare soil, baseline)                              |                                                |                                                                 | Post-restoration (vegetated)                                       |                                                |                                                                 |
|-----------------|-------------------------|--------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------|
|                 |                         | Estimated average interflow to surface water (m <sup>3</sup> /day) | Estimated average runoff (m <sup>3</sup> /day) | Estimated average recharge to groundwater (m <sup>3</sup> /day) | Estimated average interflow to surface water (m <sup>3</sup> /day) | Estimated average runoff (m <sup>3</sup> /day) | Estimated average recharge to groundwater (m <sup>3</sup> /day) |
| OB1             | 0.25                    | 30                                                                 | 172                                            | 532                                                             | 38                                                                 | 132                                            | 555                                                             |
| OB2             | 0.17                    | 21                                                                 | 117                                            | 362                                                             | 26                                                                 | 90                                             | 378                                                             |
| OB3             | 0.73                    | 89                                                                 | 502                                            | 1555                                                            | 111                                                                | 386                                            | 1621                                                            |

The volumes of interflow to surface water and recharge to groundwater are relatively similar between the pre- and post- restoration scenarios, they both increase slightly, for groundwater this is only 4%. The total volume of water entering the surface water is predicted to reduce by 17% post-restoration (as interflow and runoff). This is mainly seen as a decrease in direct runoff and a slight increase in interflow. Although not presented as an assessment outcome it is also likely that evapotranspiration will increase for the water balance for the overburden areas as a result of vegetation and soil profile establishment. The following assumptions are made for the chemical load associated with these changed flow volumes to the waterbodies:

- Seepage chemistry and interflow to surface water is, as a conservative estimate, unlikely to significantly change post restoration from the current drainage chemistry. This assumes that the chemical load as seepage from the overburden areas will continue at the current condition. The waste is classified as inert, and based on this classification is assumed to have a relatively low risk for significant metal/metalloid and sulfate impact to drainage, and is considered non-acid generating. Waste materials within the overburden areas have been in place for 15+ years and a proportion of any significant geochemical load present (or developed) within the facility will likely have drained down and been flushed through by the current time (noting water quality monitoring does not indicate evidence for increasing trends over time of key metal/metalloid species). It is not expected that the revegetation and reprofiling restoration for the overburden areas will significantly change the geochemical conditions within the overburden or the resulting chemical quality of the drainage. As such the current drainage quality and flows reporting as seepage to groundwater and interflow to surface water can reasonably be expected to remain similar, or improve for the post-closure period.

- Runoff and related potential suspended sediment load (from runoff) is assumed to likely reduce following revegetation. This is because revegetation typically reduces the quantity, intensity and speed of runoff compared to bare surfaces. The vegetation can also reasonably be expected to provide a degree of protection for the soil and material from erosion given the potential for the vegetation to stabilise the soil and material over time, and reduced run off rates/intensity. These factors mean that typically after vegetation establishment the potential suspended sediment load generated during a rainfall event decreases (Bussiere and Guitttonny, 2021). As such, the instances and magnitude of higher TSS events will likely reduce, and the risk for suspended sediment to the watercourses will reduce following restoration. As the suspended sediment can at times carry chemical load, such as metals sorbed onto particle surfaces (or colloids), it is likely the overall chemical load from metals/metalloids will reduce in the runoff from revegetated overburden areas in the post restoration period.
- Risks from existing sources of drainage/seepage – the main surface water quality drainage risk noted on site from the overburden areas is around the southern area of OB3. No other significant AMD risks have been identified within the water quality monitoring data (relative to this location). The origin of this relatively poorer quality water has not been established with confidence to date because of limited nature of investigations and as such may not be directly from drainage within the overburden. Given the point source nature of the discharge a credible alternative source for this AMD impacted drainage is outfall of drainage reporting from local buried mine workings that lie under the waste (elevated iron concentrations at neutral to alkaline pH conditions may suggest reduced iron species which are typical from underground mine workings for example). Given uncertainty in identification of the source of the impacted water, a conservative approach has been taken which is to assume that the chemical load from this source will remain at current levels post closure, and so will likely to continue to drain into the Bargoed Taf waterbody (noting that the nature of the drainage from this point has remained broadly stable since 2011 in terms of geochemical signature). The main risk to downstream water quality from this location assuming future discharges continue is therefore the ongoing function of the settling ponds to manage/mitigate the chemical loading to the receiving surface water. During the operational period monitoring data assessed suggests that settling pond(s) successfully reduce some of the metal load discharging to the Bargoed Taf waterbody. Management of ponds at Ffos y Fran to date has included regular sediment removal to ensure the settling ponds functioned in terms of water flows and settling time. Following restoration it is understood that the post closure strategy is to allow these ponds to naturalise to reduce reliance on ongoing maintenance. It is assumed that as part of naturalisation that sediment and vegetation will increase progressively in these ponds over time. This naturalisation process is assumed to result in chemical loads to continue to be reduced to receiving surface water as the ponds increasingly act as a natural wetland treatment system over time (noting these systems are commonly used as a form of passive water treatment at other mine sites in the UK). The efficacy of this process has not been determined and as such will need to be monitored, if the transition proves successful the benefits of enhancement of the system by strategies such as wetland planting can be assessed as the system develops over time (i.e. this could be best described as a nature based solution).

## 4.2 Pit void water body

An assessment of the pit void waterbody (pit lake) as a potential source of AMD impacts to receiving surface/groundwater receptors (as well as a pathway) with regards to future water quality was undertaken by completing a computer modeling exercise to consider the current and future potential water quality. The model developed is based on the water balance for the pit void waterbody produced by Groundwater Science, noting that a full description of the water balance is contained in the assessment report (Groundwater Science, 2024). Monitoring of the waterbody level commenced following the cessation of mining, and the data gathered suggests that lake level has already rebounded to its expected maximum elevation (in continuity with the groundwater level). The pit void is interpreted to act as a flow through waterbody for groundwater with groundwater inflow and outflow approximately balancing, thus the level of the waterbody is at approximate equilibrium with the surrounding groundwater level.

A conceptualisation of the pit lake waterbody is shown in Figure 23. Backfill is found mostly down hydraulic gradient of the pit void, and the Dowlais fault has been infilled in places with backfill. The pit void waterbody is assumed to not have a surface water discharge because the water level in the void is below the crest level in the pit void, meaning that no overtopping occurs. The main inflows and outflows from the water balance model are as follows:

- Inflows:
  - Groundwater inflow
  - Runoff from pit void walls
  - Direct precipitation to the pit void waterbody
  - Catchment runoff from the surrounding pit void area
- Outflows:
  - Evaporation
  - Groundwater outflow

The water balance model runs from the cessation of pumping in 2023 showing the short rebound time of the water level to reach equilibrium with the surrounding groundwater. The model then continues for approximately 40 years to simulate the expected variation over time. The model was calibrated to monitored lake levels in 2023 and 2024. The volumes predicted for the key inflows and outflows, and the overall volume of the waterbody are shown in Figure 24 and Figure 25. Pit runoff and groundwater inflow are some of the higher inputs to the waterbody, and the major discharge is as groundwater flow. Evaporation and direct precipitation to the waterbody is relatively low.

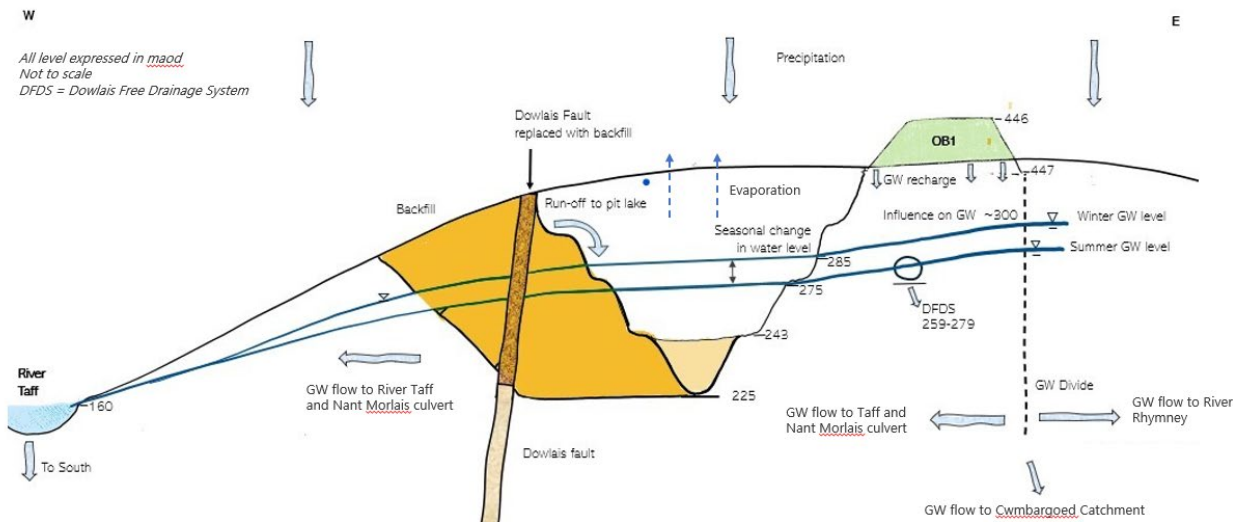


Figure 23 Conceptual model of the pit void waterbody (from Groundwater Science, 2024)

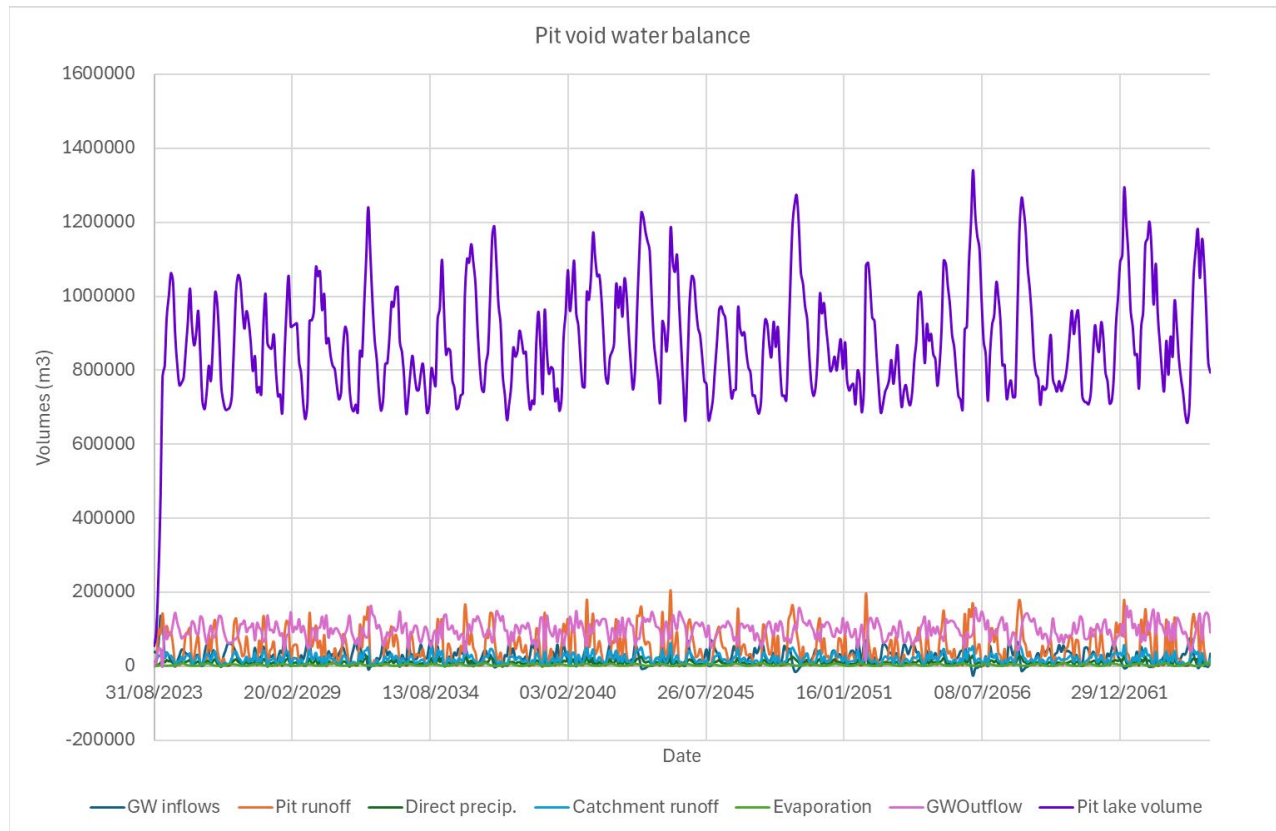


Figure 24 Pit void water balance

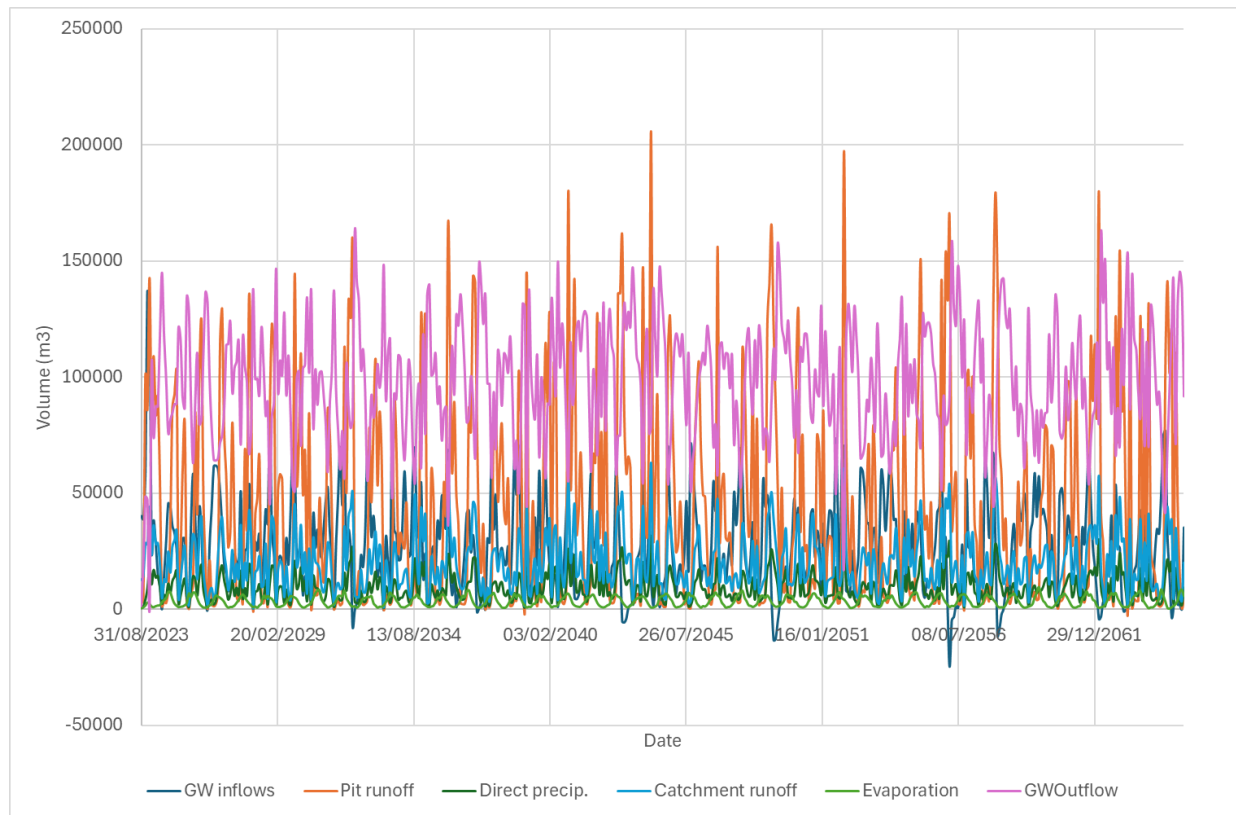


Figure 25 Key inflows and outflows for pit void waterbody

The water quality model for the pit void waterbody was developed by assigning an appropriate chemistry to each of the major inflows defined by the water balance (Table 10). The most recent monitoring data was used to assign a water quality to each inflow. The chemistry used for each inflow is as follows:

- Groundwater inflow – the average monitoring data for point 5812 was used to define water quality for upgradient groundwater inflow. Following calibration of the initial model a number of parameters were edited using the average water quality recorded in monitoring point 5808. These included alkalinity, chloride and sodium. Both of these locations monitored groundwater close to and upgradient of the pit void. The high chloride and sodium at point 5812 may have been a specific influence of the landfill site, and might not be as representative of general groundwater quality surrounding the pit. The sulfate concentration was also adjusted to match the sulfate used for the pit wall runoff, as the average concentrations for 5812 and 5808 were low as a result of a number of samples in the database that may have been errors and analyses too low. Manganese concentrations from the mine waterbody monitoring were also used as the concentrations in groundwater were variable and had declined in the last year, and a lower value may not fully represent the higher concentrations. This approach was based on a conservative assumption.
- Pit wall runoff – the direct pit wall runoff is likely to carry a small chemical load from exposed rock in the high wall. The chemistry of the mine void groundwater was used as a potential proxy for this chemical load in the pit lake model, any changes listed above should also be noted.

- Backfill material – the backfill material was not considered as a significant factor for determination of pit void water quality for two main reasons:
  - Backfill is placed down hydraulic gradient in relation to the pit void, given the pit void is considered as a “flow through” lake system significant inflows of groundwater from the backfill into the pit void (i.e. up hydraulic gradient) are not considered likely
  - Model outputs were calibrated against the existing pit void water body monitoring data to determine if there is significant difference (which would indicate a significant impact of backfill on water quality)
- Catchment runoff – the catchment runoff has been assigned the chemistry measured in OB1 (Table 3) which is thought to represent typical runoff chemistry from the wider catchment. Phosphorous and ammonia was not included in this monitoring set, so an equivalent concentration based on surface water monitoring around the site was used as proxy data.
- Direct precipitation to the waterbody – this was assumed to be a solution with low dissolved solids, a pH 5.5 and low concentration of chloride to reflect typical rainfall chemistry.

Table 10 Pit model input chemistries

| Parameter | Units | Direct precipitation | Groundwater inflow | Pit wall runoff | Catchment runoff |
|-----------|-------|----------------------|--------------------|-----------------|------------------|
| Al        | mg/L  | 0                    | 0.17               | 0.08            | 0.01             |
| Alk       | mg/L  | 0                    | 570                | 338             | 241              |
| NH3-N     | mg/L  | 0                    | 1.6                | 1.2             | 0.5              |
| As        | mg/L  | 0                    | 0.011              | 0.001           | 0.001            |
| Ca        | mg/L  | 0                    | 126                | 132             | 64               |
| Cd        | mg/L  | 0                    | 0.00022            | 0.00009         | 0.00002          |
| Cl        | mg/L  | 5                    | 95                 | 50              | 11               |
| Cu        | mg/L  | 0                    | 0.006              | 0.002           | 0.001            |
| Cr        | mg/L  | 0                    | 0.004              |                 | 0.001            |
| F         | mg/L  | 0                    | 0.2                | 0.1             | 0.1              |
| Fe        | mg/L  | 0                    | 1.70               | 0.33            | 0.01             |
| Hg        | mg/L  | 0                    | 9E-05              | 3E-05           | 3E-05            |
| K         | mg/L  | 0                    | 84                 | 52              | 45               |
| Pb        | mg/L  | 0                    | 0.0050             | 0.0010          | 0.0002           |
| Mg        | mg/L  | 0                    | 85                 | 107             | 78               |
| Mn        | mg/L  | 0                    | 0.68               | 0.77            | 0.01             |
| Mo        | mg/L  | 0                    | 0.017              | 0.002           | 0.000            |
| Na        | mg/L  | 0                    | 64                 | 41              | 10               |
| Ni        | mg/L  | 0                    | 0.03               | 0.08            | 0.03             |
| P         | mg/L  | 0                    | 0.2                | 0.1             | 0.1              |
| pH Total  | s.u.  | 5.5                  | 7.5                | 8.1             | 8.3              |

| Parameter       | Units | Direct precipitation | Groundwater inflow | Pit wall runoff | Catchment runoff |
|-----------------|-------|----------------------|--------------------|-----------------|------------------|
| Se              | mg/L  | 0                    | 0.004              | 0.001           | 0.010            |
| SO <sub>4</sub> | mg/L  | 0                    | 495                | 495             | 273              |
| Zn              | mg/L  | 0                    | 0.06               | 0.02            | 0.01             |

These chemistries were used to create a mass balance mixing model within excel by proportionally mixing each chemistry based on the proportion within the water balance. These mixes were completed on a monthly timestep for the 40 year length of the water balance. Following the first time step the chemistry created in the initial and subsequent mixes was used as the pit void waterbody chemistry and included as a component in subsequent mixes. Evaporation was assigned by increasing the mass load proportionally to estimate the volume of water removed and thus the expected increase in concentration of mass following water removal. As a conservative approach no precipitation of metals or sorption of metals onto surfaces was assumed, which would have the potential to lower the concentrations, particularly of elements such as iron which could form iron oxides. Instead mass is assumed to be retained within water solution in the model. The results of selected parameters within the model and the full model chemistry for selected years are show in Table 11 and Figure 26 to Figure 32. These results are compared against the site PAVs and current average chemistry for the pit void.

As a calibration step the modelled water chemistry in September 2024 was compared with current pit void waterbody monitoring to assess the suitability of the input chemistries. As described above a number of updates were made to the input chemistries to better align the modelled results to monitored data.

The results suggest that following the formation of the pit lake the chemistry predicted remains relatively stable, as the inflows are relatively balanced and the water chemistry is dominated by the already existing lake chemistry. pH is predicted to be around 8, and sulfate 300 – 250 mg/L. The following parameters are at times elevated at or above the site PAVs:

- NH<sub>3</sub>-N – this is modelled to be around 1.5 mg/L. The high concentration is in particular linked to the measured ammonia concentration in upgradient groundwater. Given the high concentrations (10 mg/L) measured in the landfill perimeter borehole GW02 it is thought that the key source of ammonia in the model is potentially the landfill.
- Fe – iron is initially elevated above the PAV but drops to below 1 mg/L within a few months.
- K – remains slightly higher than the PAV (~50 – 60 mg/L) in the model. This is similar to monitored groundwater upgradient of the pit. Higher potassium could also be linked to the landfill upgradient of the pit void.
- Mn – the modelled concentration in the early model (calibration period) is slightly lower than the currently monitored values. This is mainly due to manganese averages in groundwater are potentially lower than expected given the model, these were increased during the calibration step. The modelled concentrations are elevated above site PAVs.

- P – is at around the current PAVs, modelled between 0.1 and 0.2 mg/L which is around the measured data. The background P concentrations in baseline ground and surface waters are generally high in the area and chemical load maybe from upgradient sources from the pit void.

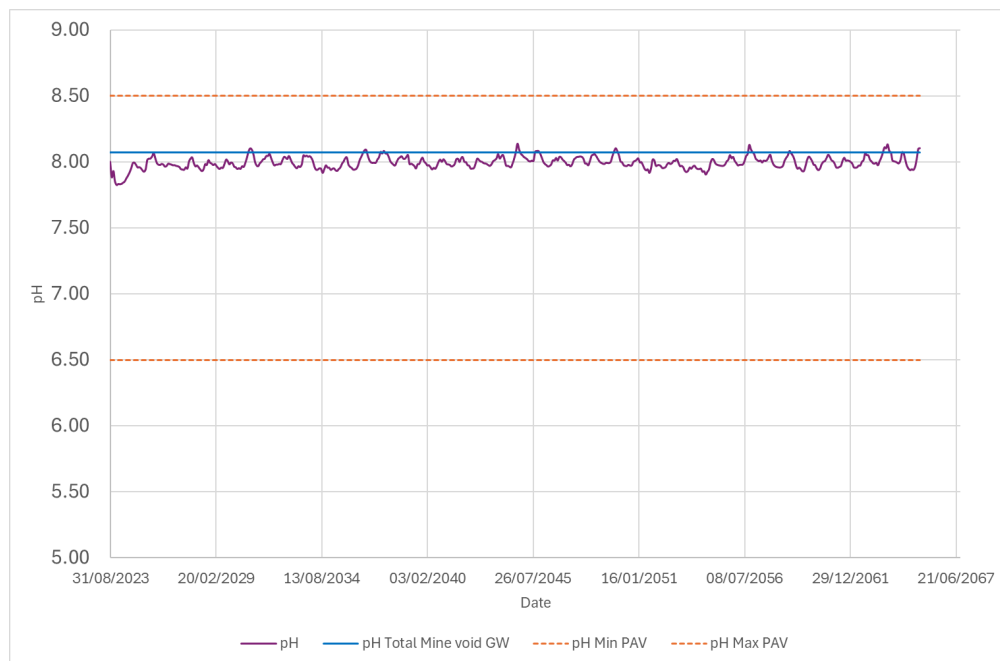


Figure 26 Modelled pH in the pit void waterbody

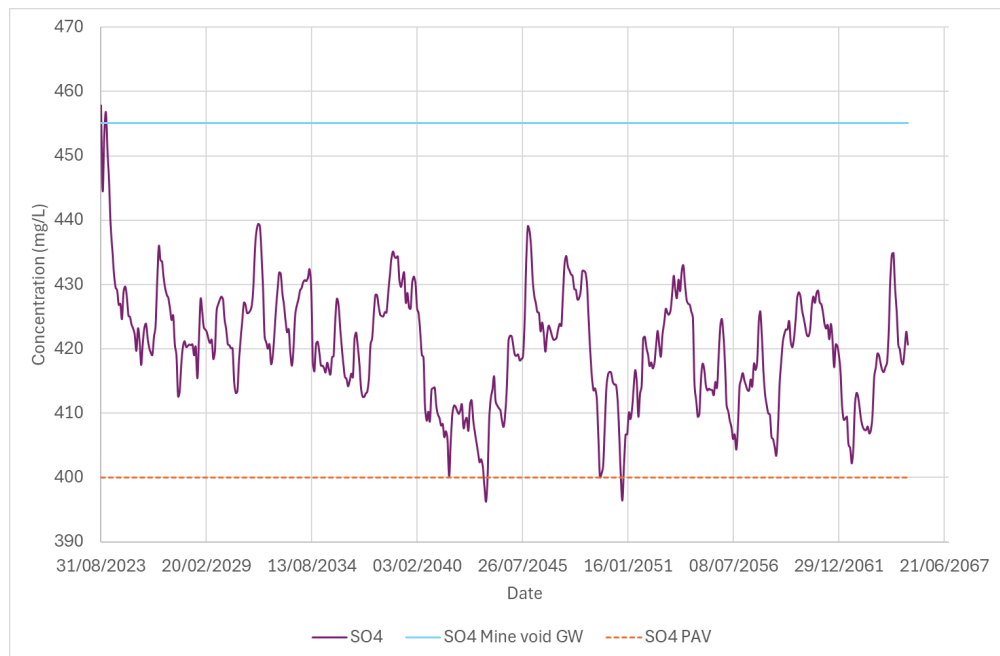


Figure 27 Modelled sulfate in the pit void waterbody

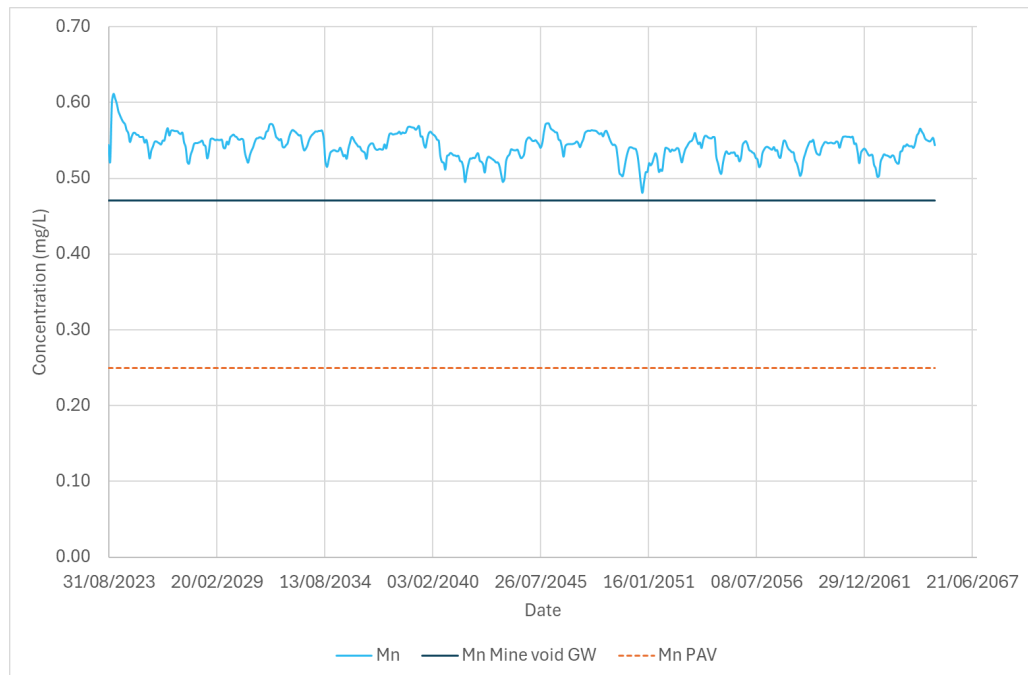


Figure 28 Modelled manganese in the pit void waterbody

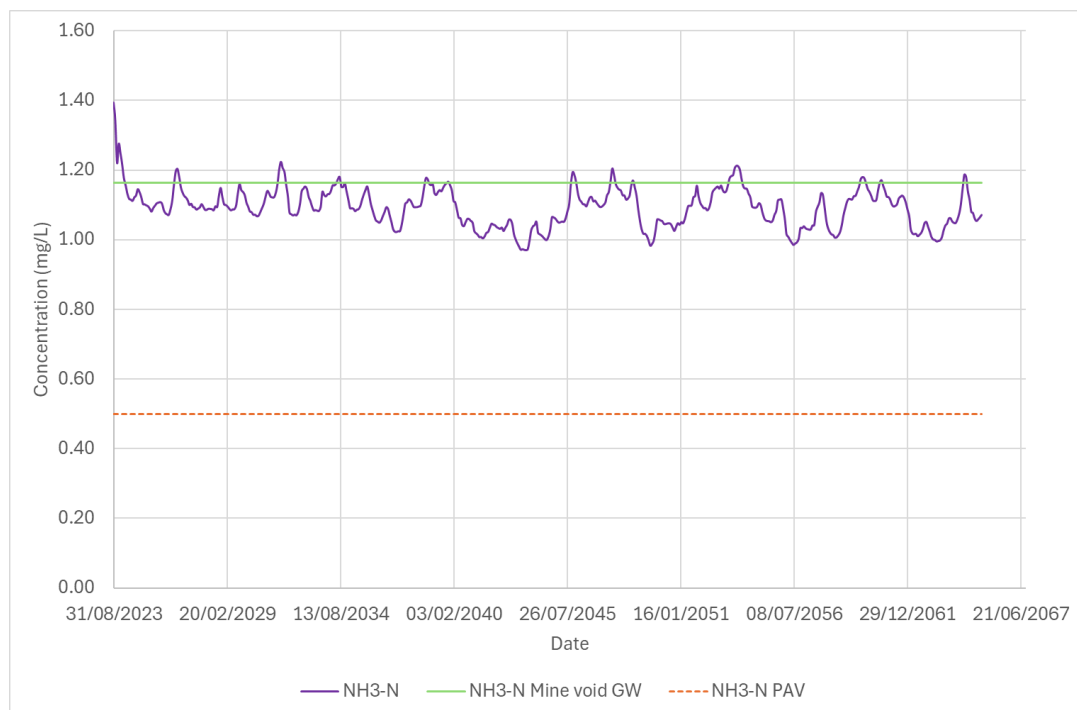


Figure 29 Modelled NH3-N in the pit void waterbody

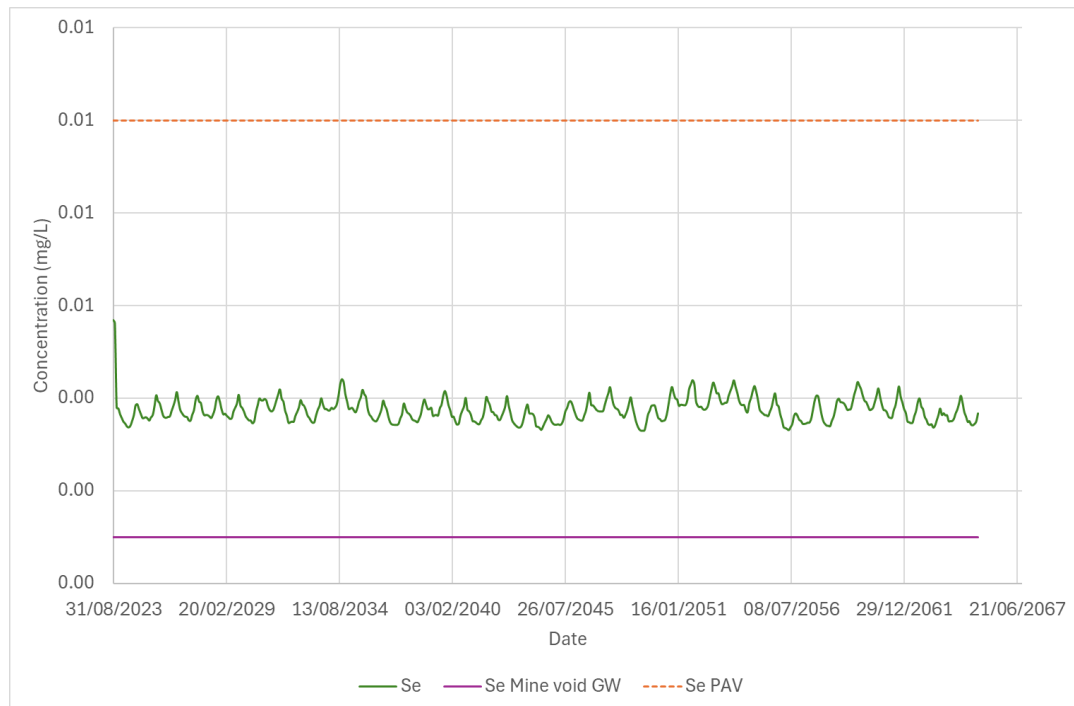


Figure 30 Modelled Se in the pit void waterbody

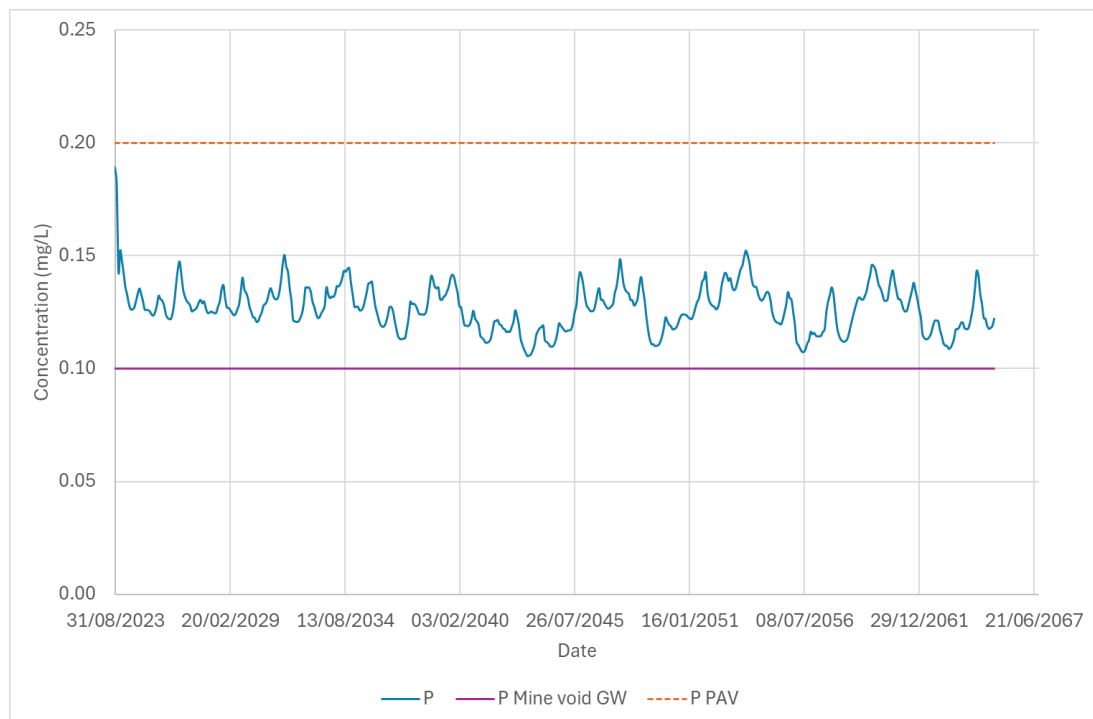


Figure 31 Modelled P concentrations in the pit void waterbody

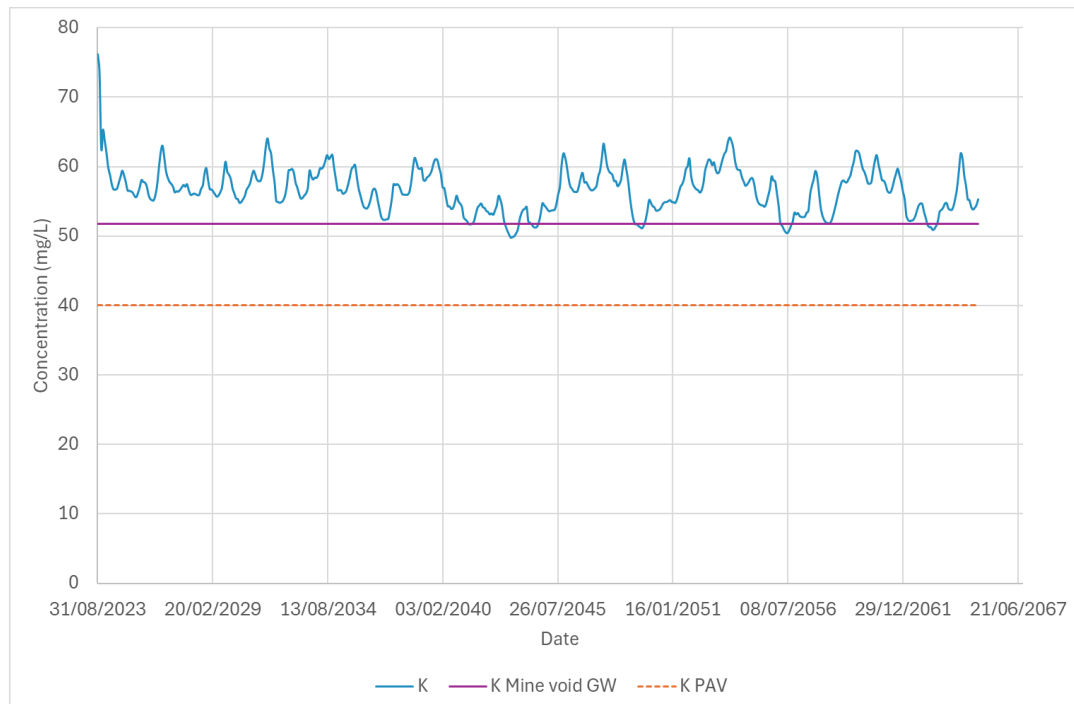


Figure 32 Modelled K in the pit void waterbody

Table 11 Summary of selected pit void water body results (colouration of values indicates exceedance of PAV)

| Parameter          | Units                  | Average of mine groundwater | PAV   | 31/08/2023 | 30/09/2024 | 28/02/2026 | 31/05/2030 | 31/08/2035 | 31/12/2045 | 31/07/2055 | 28/02/2065 |
|--------------------|------------------------|-----------------------------|-------|------------|------------|------------|------------|------------|------------|------------|------------|
| Al                 | mg/L                   | 0.077                       | 0.5   | 0.13       | 0.09       | 0.08       | 0.08       | 0.09       | 0.09       | 0.08       | 0.08       |
| Alkalinity         | mg/L CaCO <sub>3</sub> | 338                         |       | 499        | 378        | 356        | 352        | 377        | 389        | 358        | 355        |
| NH <sub>3</sub> -N | mg/L                   | 1.16                        | 0.5   | 1.4        | 1.1        | 1.1        | 1.1        | 1.1        | 1.2        | 1.1        | 1.1        |
| As                 | mg/L                   | 0.0011                      | 0.01  | 0.009      | 0.004      | 0.004      | 0.003      | 0.004      | 0.005      | 0.004      | 0.004      |
| Ca                 | mg/L                   | 132                         | 250   | 115        | 109        | 109        | 109        | 108        | 113        | 107        | 109        |
| Cd                 | mg/L                   | 0.00009                     | 0.005 | 0.00017    | 0.00011    | 0.00010    | 0.00010    | 0.00011    | 0.00012    | 0.00010    | 0.00010    |
| Cl                 | mg/L                   | 50.3                        | 250   | 76         | 55         | 51         | 51         | 55         | 57         | 51         | 51         |
| Cu                 | mg/L                   | 0.002                       | 0.2   | 0.005      | 0.003      | 0.003      | 0.003      | 0.003      | 0.003      | 0.003      | 0.003      |
| Cr                 | mg/L                   |                             | 0.03  | 0.0035     | 0.0017     | 0.0013     | 0.0012     | 0.0017     | 0.0017     | 0.0014     | 0.0013     |
| F                  | mg/L                   | 0.14                        | 1.5   | 0.19       | 0.15       | 0.14       | 0.14       | 0.15       | 0.15       | 0.14       | 0.14       |
| Fe                 | mg/L                   | 0.325                       | 1     | 1.3        | 0.7        | 0.6        | 0.6        | 0.7        | 0.7        | 0.6        | 0.6        |
| Hg                 | mg/L                   | 0.00003                     | 0.001 | 0.00007    | 0.00005    | 0.00004    | 0.00004    | 0.00005    | 0.00005    | 0.00004    | 0.00004    |
| K                  | mg/L                   | 51                          | 40    | 76         | 58         | 55         | 54         | 58         | 60         | 55         | 55         |

|                 |      |        |              |       |       |       |       |       |       |       |       |
|-----------------|------|--------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Pb              | mg/L | 0.001  | 0.1          | 0.004 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| Mg              | mg/L | 106    | 100          | 87    | 88    | 89    | 89    | 87    | 90    | 88    | 89    |
| Mn              | mg/L | 0.771  | 0.25         | 0.54  | 0.55  | 0.55  | 0.55  | 0.53  | 0.57  | 0.53  | 0.55  |
| Mo              | mg/L | 0.0016 | 0.05         | 0.013 | 0.006 | 0.005 | 0.005 | 0.006 | 0.007 | 0.005 | 0.005 |
| Na              | mg/L | 41     | 170          | 52    | 40    | 38    | 38    | 40    | 42    | 38    | 38    |
| Ni              | mg/L | 0.083  | 0.1          | 0.04  | 0.05  | 0.05  | 0.06  | 0.05  | 0.05  | 0.05  | 0.05  |
| P               | mg/L | 0.1    | 0.2          | 0.2   | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   | 0.1   |
| pH              | s.u. | 8.07   | 6.5 -<br>8.5 | 8.0   | 8.0   | 8.0   | 7.9   | 8.0   | 8.0   | 8.0   | 7.9   |
| Se              | mg/L | 0.001  | 0.01         | 0.006 | 0.004 | 0.004 | 0.003 | 0.004 | 0.004 | 0.004 | 0.003 |
| SO <sub>4</sub> | mg/L | 455    | 400          | 458   | 425   | 420   | 420   | 419   | 436   | 415   | 420   |
| Zn              | mg/L | 0.0185 | 0.1          | 0.05  | 0.03  | 0.03  | 0.02  | 0.03  | 0.03  | 0.03  | 0.03  |

### 4.3 Assessment of potential water quality impacts

As described in Section 4.1 the historical and ongoing drainage from the south of OB3 is considered a potential future risk to water quality in the Bargoed Taf waterbody. Following a review of current and historical monitoring, and the ecological assessments completed in 2014 and 2015, the ongoing drainage characteristics were assessed to be similar to those assessed previously and as such ecological impacts are likely similar to previously assessed. As such, in the near term potential risks to downstream water quality deterioration are considered relatively low given that a driver for significant changes in discharge water quality has not been identified. It is noted that based on findings of this assessment, the settling ponds are interpreted to remove (and have removed) metal loads from impacted drainage (from OB3 catchment) and so are likely mitigating impacts to receiving surface water quality. As it can be reasonably concluded that after restoration is completed, the ongoing performance of the ponds will likely be a relevant factor for assessing future discharge (and receiving) surface water quality. If it is assumed that the ponds will continue to provide similar level of surface water quality mitigation (i.e. reduced metal loads) in the post restoration time period, the discharge quality to the Bargoed Taf may be assumed to be maintained within a similar range to that currently recorded (i.e. supporting a generally low risk classification). Given the identified positive influence of the ponds on current (and historic) discharge water quality, management, monitoring and maintenance of the settling ponds following restoration will therefore likely be required to ensure ongoing risks to receiving water quality are mitigated to a similar level as currently observed (i.e. maintain low risk scenario).

Based on the positive influence of the ponds on discharge surface water quality identified to date from monitoring data, there are opportunities to identify options to further enhance water quality mitigation of drainage from OB3 area as part of restoration. For example nature based solutions such as the addition of wetland areas in both the settlement pond and outfall areas (with appropriate vegetation), may further assist with management of discharge water quality in the post restoration period from this source, and Bargoed Taf watercourse.

Downgradient effects of the mine void water quality were assessed using a flowpath model by Groundwater Science, described fully in their report (Groundwater Science, 2024). This assessed the proportion of water from the pit lake waterbody that travelled downgradient both within the groundwater and then exited to surface water. The main flow path in the model is to the south west towards the River Taff. A visual representation of the fraction of water on these flowpaths is shown in Figure 33 and Figure 34.

The proportion of groundwater that was originally found in pit void, or is discharging from the groundwater and originated in the pit void waterbody is relatively low at points which are identified as potential receptors. The groundwater monitoring location 5824 is at the south west boundary of the Ffos y Fran site and it has been used as a receptor location to indicate groundwater quality leaving the site. The mine void waterbody makes up ~2% of groundwater at this location.

The River Taff to the south west is also assigned as downgradient receptor based on the flowpath model. The proportion of groundwater that originated in the pit void waterbody is estimated at around 1.4%. The proportion as baseflow groundwater to the River Taff is estimated to be on average 2.5% in the reach of the river where it appears groundwater is discharging.

These estimations show the proportion of water originating from the pit void water body that discharges to the wider ground and surface water receptors is very low and that there is a large volume of dilution from the wider ground and surface water systems.

A dilution model using background groundwater and surface water monitoring data was completed using these proportions and the results are shown in Table 12. The average chemistry of groundwater at 5824 was used as the background baseline chemistry. Monitoring data was unavailable for the River Taff, so the average monitoring data from MA3 (Nant Morlais, River Taff tributary) was used as the background baseline chemistry for surface water. The average and maximum modelled concentrations modelled within the pit void model were used as source term chemistry. A simple dilution mix based on the predicted fraction of source water and downgradient baseline chemistry was completed.

Although sulfate, manganese and ammonia are elevated in the pit void waterbody source term model, the levels within the receptor dilution location mixes are much lower, below site PAVs. Phosphorous is elevated in the dilution mixes, at the PAVs in some instances. Iron is also elevated, however the source of these species appears to be related to background baseline groundwater quality rather than from the pit void waterbody as a source.

Overall the results of the dilution mixes suggest the risk to downgradient receptors from the pit void waterbody is relatively low, and only minor changes in baseline chemistry load are predicted. Parameters which are elevated tend to be in line with baseline chemistry for the area.

It is noted that the pit void water body has not been considered as only a receptor as part of this assessment because it is considered a source of potential water quality impacts to downgradient receiving water bodies and simultaneously as a pathway for upgradient groundwater (and related sources) given the flow through hydrological conceptualisation of the water body with respect to groundwater.



Modelling carried out suggests that upgradient groundwater quality currently (and in the future) dominates the water quality of this water body, the pit void water quality is assumed therefore to largely reflect groundwater quality. Exceedances of PAVs are noted as follows:

- NH<sub>3</sub>-N – this is modelled to be around 1.5 mg/L. The high concentration is in particular linked to the measured ammonia concentration in upgradient groundwater.
- Fe – iron is initially elevated above the PAV but drops to below 1 mg/L within a few months.
- K – remains slightly higher than the PAV (~50 – 60 mg/L) in the model. This is similar to monitored groundwater upgradient of the pit.
- Mn – The modelled concentrations are slightly elevated above site PAVs.
- P – is around the current PAVs, modelled at around 0.1 – 0.2 mg/L. The background P concentrations in baseline ground and surface waters are generally high in the area and chemical load maybe from upgradient sources from the pit void.

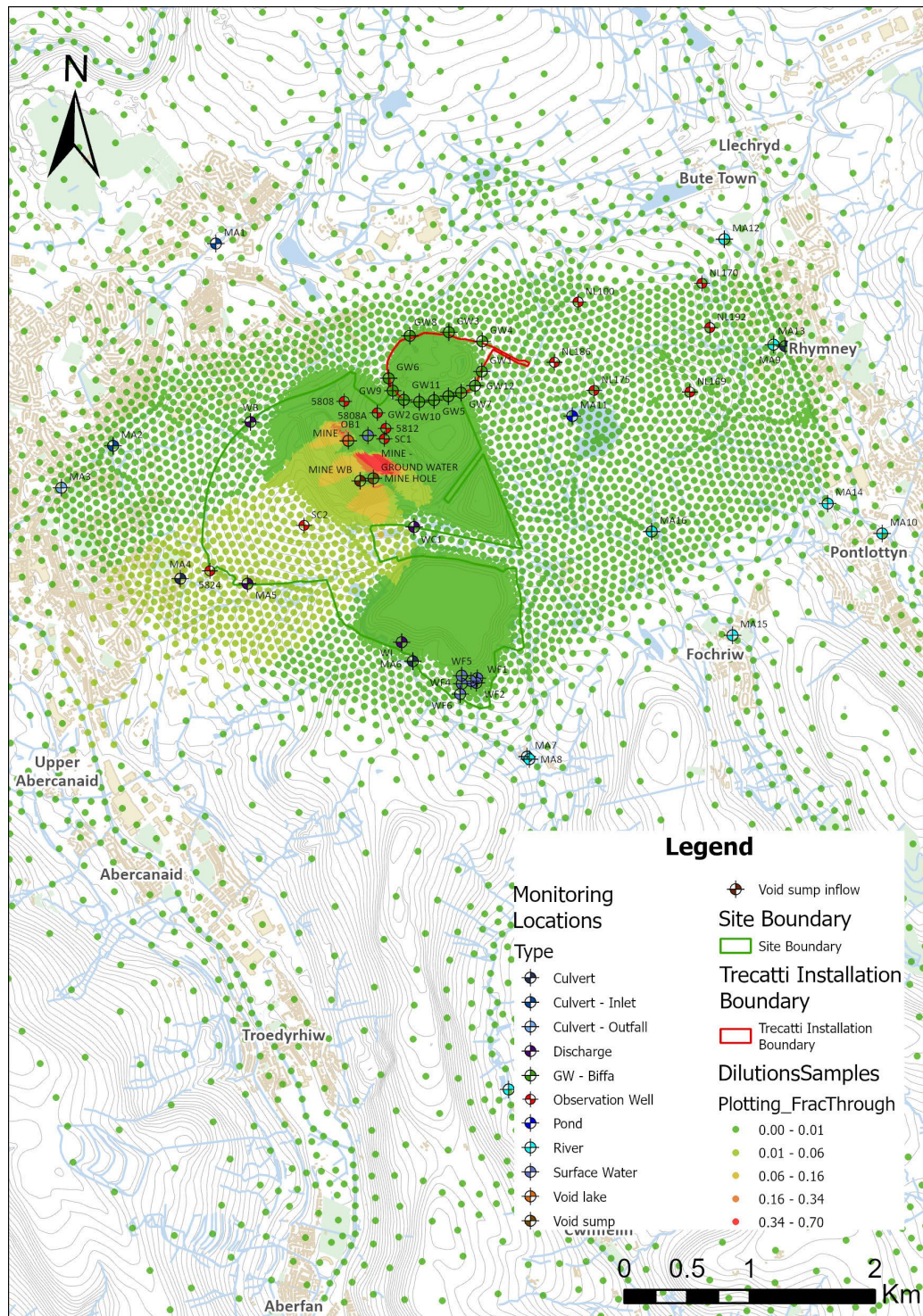


Figure 33 Fraction of groundwater in the groundwater model that is from the pit void

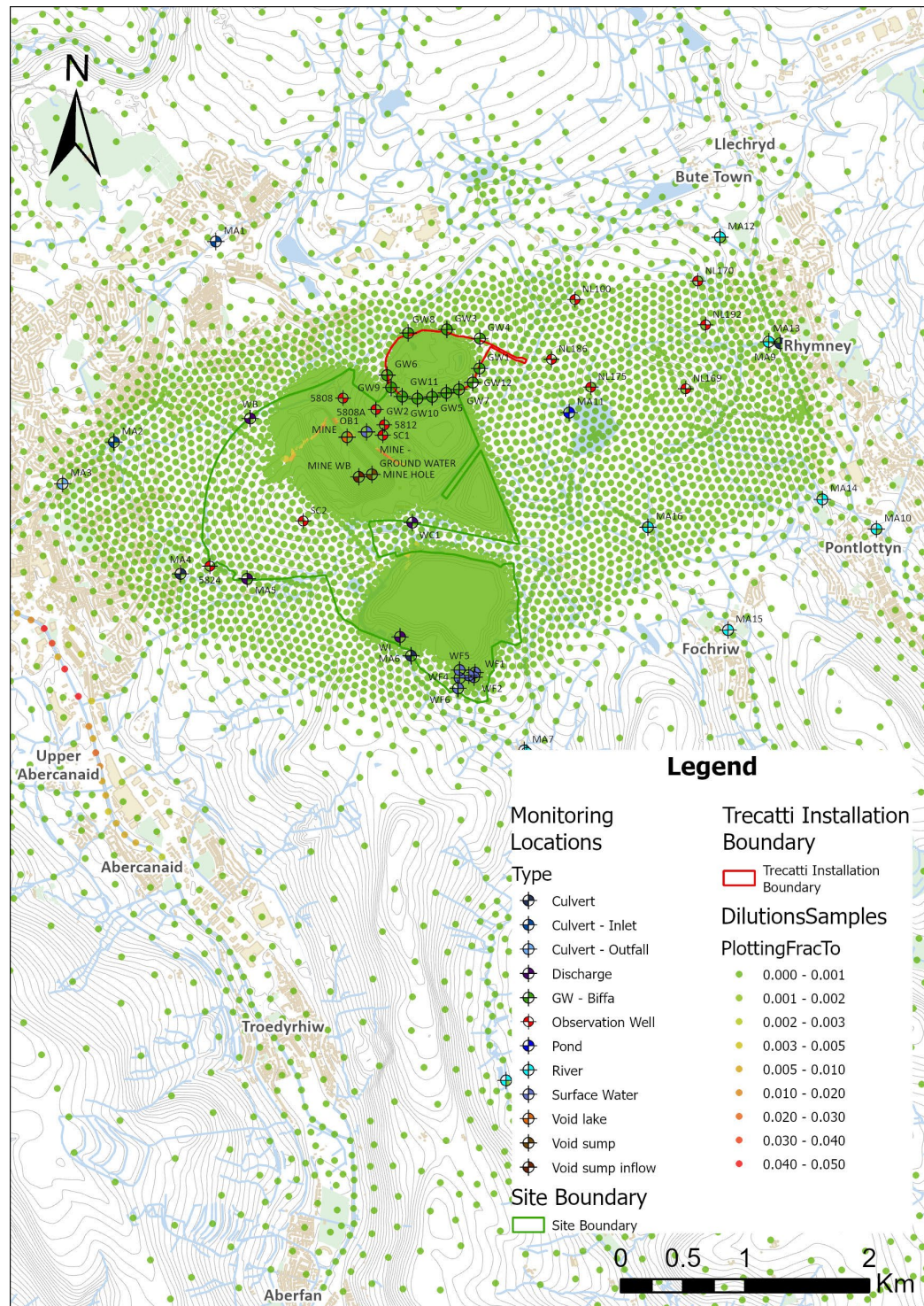


Figure 34 Fraction of water leaving the groundwater model that is from the pit void



Table 12 Dilution calculations for groundwater and surface water receptors from pit void groundwater source

| Parameter  | Units      | PAV       | Average<br>5824 | MA3<br>(proxy for<br>River<br>Taff) | Modelled pit void<br>chemistry |        | Fraction mix – average model |                                     |                                      | Fraction mix – max model |                         |                             |
|------------|------------|-----------|-----------------|-------------------------------------|--------------------------------|--------|------------------------------|-------------------------------------|--------------------------------------|--------------------------|-------------------------|-----------------------------|
|            |            |           |                 |                                     | Average                        | Max    | 5824                         | River Taff -<br>GW flow<br>fraction | River Taff -<br>GW to SW<br>fraction | 5824                     | River Taff<br>- GW flow | River Taff<br>- GW to<br>SW |
|            |            |           |                 |                                     |                                |        | 0.02                         | 0.014                               | 0.025                                | 0.02                     | 0.014                   | 0.025                       |
| Al         | mg/L       | 0.5       | 0.13            | 0.07                                | 0.08                           | 0.13   | 0.13                         | 0.13                                | 0.07                                 | 0.13                     | 0.13                    | 0.07                        |
| Alkalinity | mg/L CaCO3 |           | 263.4           | 188.2                               | 364.1                          | 498.5  | 265.4                        | 264.8                               | 192.6                                | 268.1                    | 266.7                   | 195.9                       |
| NH3-N      | mg/L       | 0.5       | 0.16            | 0.39                                | 1.09                           | 1.39   | 0.18                         | 0.18                                | 0.41                                 | 0.19                     | 0.18                    | 0.42                        |
| As         | mg/L       | 0.01      | 0.003           | 0.002                               | 0.004                          | 0.009  | 0.003                        | 0.003                               | 0.002                                | 0.003                    | 0.003                   | 0.002                       |
| Ca         | mg/L       | 250       | 23.8            | 84.0                                | 108.5                          | 117.7  | 25.6                         | 25.1                                | 84.6                                 | 25.7                     | 25.2                    | 84.9                        |
| Cd         | mg/L       | 0.005     | 0.0003          | 0.0005                              | 0.0001                         | 0.0002 | 0.0003                       | 0.0003                              | 0.0004                               | 0.0003                   | 0.0003                  | 0.0004                      |
| Cl         | mg/L       | 250       | 39              | 37                                  | 52                             | 76     | 39                           | 39                                  | 38                                   | 39                       | 39                      | 38                          |
| Cu         | mg/L       | 0.2       | 0.018           | 0.005                               | 0.003                          | 0.005  | 0.018                        | 0.018                               | 0.005                                | 0.018                    | 0.018                   | 0.005                       |
| Cr         | mg/L       | 0.03      | 0.002           | 0.002                               | 0.001                          | 0.004  | 0.002                        | 0.002                               | 0.002                                | 0.002                    | 0.002                   | 0.002                       |
| F          | mg/L       | 1.5       | 0.4             | 0.2                                 | 0.1                            | 0.2    | 0.4                          | 0.4                                 | 0.2                                  | 0.4                      | 0.4                     | 0.2                         |
| Fe         | mg/L       | 1         | 1.4             | 0.2                                 | 0.6                            | 1.3    | 1.4                          | 1.4                                 | 0.2                                  | 1.4                      | 1.4                     | 0.3                         |
| Hg         | mg/L       | 0.001     | 0.0002          | 0.0002                              | 0.0000                         | 0.0001 | 0.0002                       | 0.0002                              | 0.0002                               | 0.0002                   | 0.0002                  | 0.0002                      |
| K          | mg/L       | 40        | 9.0             | 14.0                                | 56.6                           | 76.2   | 10.0                         | 9.7                                 | 15.1                                 | 10.4                     | 10.0                    | 15.6                        |
| Pb         | mg/L       | 0.1       | 0.007           | 0.003                               | 0.002                          | 0.004  | 0.007                        | 0.007                               | 0.003                                | 0.007                    | 0.007                   | 0.003                       |
| Mg         | mg/L       | 100       | 4.0             | 26.9                                | 88.2                           | 92.5   | 5.7                          | 5.2                                 | 28.5                                 | 5.8                      | 5.3                     | 28.6                        |
| Mn         | mg/L       | 0.25      | 0.06            | 0.10                                | 0.54                           | 0.61   | 0.07                         | 0.06                                | 0.11                                 | 0.07                     | 0.07                    | 0.11                        |
| Mo         | mg/L       | 0.05      | 0.002           | 0.007                               | 0.006                          | 0.013  | 0.002                        | 0.002                               | 0.007                                | 0.002                    | 0.002                   | 0.007                       |
| Na         | mg/L       | 170       | 99.1            | 23.8                                | 38.9                           | 52.1   | 97.9                         | 98.3                                | 24.2                                 | 98.2                     | 98.5                    | 24.5                        |
| Ni         | mg/L       | 0.1       | 0.006           | 0.015                               | 0.053                          | 0.058  | 0.007                        | 0.006                               | 0.016                                | 0.007                    | 0.006                   | 0.016                       |
| P          | mg/L       | 0.2       | 0.2             | 0.1                                 | 0.1                            | 0.2    | 0.2                          | 0.2                                 | 0.1                                  | 0.2                      | 0.2                     | 0.1                         |
| pH         | s.u.       | 6.5 - 8.5 | 7.6             | 7.7                                 | 8.0                            | 8.1    | 7.7                          | 7.7                                 | 7.7                                  | 7.7                      | 7.7                     | 7.7                         |
| Se         | mg/L       | 0.01      | 0.001           | 0.002                               | 0.004                          | 0.006  | 0.001                        | 0.001                               | 0.002                                | 0.001                    | 0.001                   | 0.002                       |
| SO4        | mg/L       | 400       | 39              | 125                                 | 420                            | 458    | 46                           | 44                                  | 133                                  | 47                       | 45                      | 133                         |
| Zn         | mg/L       | 0.1       | 0.023           | 0.015                               | 0.027                          | 0.046  | 0.023                        | 0.023                               | 0.015                                | 0.023                    | 0.023                   | 0.016                       |

A summary of the risk assessment with regards to potential impacts and the significance for each receptor monitoring location is shown in Table 13.

*Table 13 Summary of risk assessment*

| <b>Assessment location</b>                                   | <b>Potential impact</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Significance / Risk</b>                                                                           | <b>Mitigation / monitoring required</b>                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bargoed Taf downstream of OB3 (Current monitoring locations) | Interpretation of historical baseline data for discharges from this location, and ecological impact assessments, suggests current impacts are limited and there is unlikely to be significant change to the source discharge chemistry in the future (noting the trend in sulfate concentration is decreasing over the long term). As such water quality is interpreted to remain within a similar range to current levels following restoration. However, the current settling ponds are recognised to likely exert a positive impact on discharge water quality, as such monitoring and/or management and/or maintenance is recommended for a period of time during and post restoration time to ensure this positive benefit continues following restoration (to the extent that water quality is maintained within current/historical range). | Low risk with current mitigation measures                                                            | Continue monitoring discharges from the south of OB3 and within the current locations on the Bargoed Taf. Determine requirements for, and implementation of a program of management/maintenance of settling ponds. Determine potential benefit of establishing a nature based solution such as a wetland system downstream of outfall locations to provide post restoration water quality mitigation for the historical discharges. |
| Groundwater (monitoring at 5824)                             | Future changes to the chemical loading from the pit void waterbody to downgradient groundwater are not considered to be significant. The main water quality impact in this area appears to relate to ammonia and the source for this is not interpreted to be from Ffos y Fran site direct but more likely to be from the landfill or diffuse offsite sources.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Low under current conditions (noting that upgradient sources are outside of the control of the site) | Continue monitoring of upgradient impacts from offsite sources in particular the landfill                                                                                                                                                                                                                                                                                                                                           |
| Surface water abstractions and supplies (River)              | Based on the results of the assessment there is not likely to be a significant change to the current baseline chemical load from the sources modelled in the assessment in these waterbodies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Insignificant                                                                                        | None                                                                                                                                                                                                                                                                                                                                                                                                                                |



| Assessment location      | Potential impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Significance / Risk                                                                                                                       | Mitigation / monitoring required                                                                       |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Rhymney and Taf Bargoed) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                           |                                                                                                        |
| WFD surface water bodies | Very low likelihood of significant changes to the chemical loading of water bodies, based on direct discharges or source dilution within groundwater (discharging to surface water bodies)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Low                                                                                                                                       | Monitoring the pit void water quality                                                                  |
| WFD groundwater bodies   | Very low likelihood of significant changes to the chemical loading of water bodies differing from baseline data, based on direct discharges or seepage to ground (discharging to surface water bodies)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Low                                                                                                                                       | Monitoring the pit void water quality                                                                  |
| Pit void water body      | Based on modelling results there is not likely to be a significant change in water quality in the pit void in the post restoration period relative to current conditions as a result of the restoration program of works. It is noted that upgradient impacts from offsite sources such as the landfill may be influencing certain parameters (e.g. ammonia) and these are outside the control of the site and so remain as a risk. Modelling results suggest that some parameters (iron, manganese, ammonia and sulfate) will be higher than PAVs during and for a period post restoration, due to the dominant influence of groundwater on water quality. The suitability of PAVs for use as water quality targets for the pit void water requires review. | Review of suitability of PAVs for pit void water quality targets (noting that upgradient sources are outside of the control of the site). | Monitoring the pit void water quality<br>Review of PAVs as post-closure pit void water quality targets |

#### 4.4 Mitigation measures

The restoration plan includes the naturalisation of settlement ponds on the site (as a nature based solution). As identified in this assessment the settlement ponds to the south of OB3 are currently effectively reducing

metal loads from impacted seepage in this area (e.g. iron and manganese). Should these be allowed to naturalise the settlement ponds may become less effective over time for removal of the metals from the drainage. As such, a program of monitoring is recommended along with establishment of a plan for settling pond management/maintenance and consideration of the benefits of constructing an enhanced wetland to ensure the removal of metal load in this location continues in the time period post restoration.

The area just under the outfall south of OB3 has also been identified as a potential long term risk for downstream water quality, noting that results of previous baseline and ecological monitoring suggests the risk is relatively low. However, it has been recognised that encouraging the formation of a larger wetland area where the outfall is located could help reduce overall metal loads to the Bargoed Taf. As such it is recommended that the opportunity and potential benefits of enhancing the existing wetland area populated with planting (such as reeds) which may encourage settlement of metals at this location are assessed.

Modelling results for the pit void water body suggest that some parameters (iron, manganese, ammonia and sulfate) will be higher than PAVs during and for a period post restoration, due to the dominant influence of groundwater on water quality. The suitability of PAVs for use as water quality targets for the pit void water requires review given the water body does not have direct connection to surface water bodies with established ecological function (and sensitive ecological receptors such as fish) and the ecological function of the water body itself has not been determined.

## **4.5 Monitoring**

The following monitoring is recommended for a minimum of 3 years within the 5 year monitoring and maintenance period, with reviews annually:

- Monitoring of pit void water body and key outfalls and seepage areas from the southern edge of OB3
- Monitoring of groundwater location(s) upgradient of the pit void, between the pit void and the Trecatti landfill, to establish any changes to offsite groundwater quality
- Downstream monitoring in the Bargoed Taf and Nant Gyward
- Groundwater monitoring downgradient of the pit void at 5824
- Monitoring of Nant Morlais watercourse based on discharges from the DFDS
- Monitoring in the River Taff based on assessment of the groundwater flow path

A review of parameters to be monitored should be undertaken but it is likely to require including major ions (including sulfate), pH, EC, nutrients and a metals suite as appropriate to the risks identified. The amount of organics monitoring could be reduced following cessation of operations on site. It is recommended that mecoprop, tritium and ammonia are included in the pit void waterbody due to the potential impact from the Trecatti landfill.

## **4.6 Cumulative effects**

Within the assessment two main cumulative effects have been noted:

- High concentrations of ammonia were measured in GW02, a perimeter borehole on the Trecatti landfill. This location is directly upgradient (groundwater flow) of the pit void. Groundwater monitoring has shown an increase in ammonia in some locations within the pit void, and the level of ammonia measured in the pit waterbody and modelled over a longer time period is found to be elevated (noting the source may be from offsite sources such as Trecatti rather than exclusively from the Ffos-y-Fran site).
- Phosphorous concentrations in the downgradient groundwater from the pit void are relatively high. These appear to be related to background groundwater levels based on information from the WFD groundwater body.

## **4.7 Summary of significant effects**

The hydrogeochemical impact assessment of the proposed restoration scheme implementation does not identify a high risk of significant effects to identified downstream recipient water quality (i.e. deterioration in water quality) will occur post closure as a result of the proposed scheme.

The pit void water body has not been considered as purely a receptor as part of this assessment because it is considered a source of potential water quality impacts to downgradient receiving water bodies and simultaneously as a pathway for upgradient groundwater (and related offsite sources) given the flow through hydrological conceptualisation of the water body with respect to groundwater. Modelling carried out suggests that upgradient groundwater quality currently (and in the future) dominates the water quality of this water body, the pit void water quality is assumed therefore to largely reflect groundwater quality. Modelling results suggest that some parameters (e.g. manganese and ammonia) will be higher than PAVs during and (for a period) post restoration, due to the dominant influence of groundwater on water quality.

Existing surface water management features such as the sediment ponds downstream of OB3 are recognised to currently have a positive influence on receiving downstream surface water quality (reduction in metal loading e.g. iron and manganese). As part of nature based solution naturalisation of these ponds is expected to occur post restoration period, as such a program of monitoring, management and maintenance is recommended for these ponds to determine impacts on future water quality, to be reviewed annually.

The opportunity and benefits of enhanced nature based solutions such as wetland construction is also recommended as part of this assessment.

Monitoring is proposed as a post closure mitigation (and assurance) measure to enable validation of the predictions made as part of this assessment and to identify any interventions that may be required. In



particular it is noted that the influence of offsite sources that may impact future water quality such as the Trecatti landfill are largely outside the control of the site. As such monitoring and annual reviews will provide valuable source of data to assess any significant changes to upgradient groundwater quality that may impact water quality on the site.

## 5 CONCLUSIONS

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An AMD risk assessment has been completed for the current and future Ffos-y-Fran site based on the current restoration plan(s). The potential effects on water quality in identified receptors from implementation of the restoration plans were considered following technical assessment. A review of the hydrogeology, hydrology, geology, water quality monitoring, permitting and relevant legislation information were all reviewed. The original EMMS was considered, and additional samples of backfill, overburden and soil forming material were tested. The current baseline for the site was summarised and water quality records were found to be similar historically to current monitoring. The Trecatti landfill site has been identified as a potential offsite landuse that affects the groundwater chemistry within the Ffos-y-Fran boundary. Following a site walkover (and water sampling), the drainage from the south of OB3 was considered as potential source of AMD risk.

A conceptual model was developed to define the potential sources (on site includes overburden and the pit void waterbody, and offsite to include the landfill), the pathways (surface and groundwater flow paths including the pit void) and potential receptors (downstream surface and groundwater bodies). An AMD assessment linking the sources and downstream water quality effects was completed for the overburden and pit void waterbody sources (with the upgradient landfill considered as an offsite source outside the control of the site).

Elevated concentrations of metals are noted to be present in recent/current surface water drainage discharges from OB3, however these are similar to those historically measured in the Bargoed Taf waterbody, and it is not expected that concentrations will increase in the future as a result of the restoration (sulfate which is a key indicator of AMD impact is noted to display a declining trend with time in this location). It is noted that an ecological assessment was completed for the Bargoed Taf in 2014 and 2015 which concluded that the drainage discharge only had a minor impact on the waterbody. The existing sediment ponds downstream of OB3 are recognised to currently have a positive influence on receiving downstream surface water quality (reduction in metal loading e.g. iron and manganese). As part of nature based solution naturalisation of these ponds is expected to occur post restoration period, as such a program of monitoring, management and maintenance is recommended for these ponds to determine impacts on future water quality. The opportunity and benefits of enhanced nature based solutions such as wetland construction is also recommended as part of this assessment.

The area just under the outfall south of OB3 has also been identified as a potential long term risk for downstream water quality, noting that results of previous baseline and ecological monitoring suggests the risk is relatively low. However, it has been recognised that encouraging the formation of a larger wetland area where the outfall is located could help reduce overall metal loads to the Bargoed Taf. As such it is recommended that the opportunity and potential benefits of enhancing the existing wetland area populated with planting (such as reeds) which may encourage settlement of metals at this location are assessed



Monitoring is proposed as a post closure mitigation (and assurance) measure to enable validation of the predictions made as part of this assessment and to identify any interventions that may be required. In particular it is noted that the influence of offsite sources that may impact future water quality such as the Trecatti landfill are largely outside the control of the site. As such monitoring and annual review will provide valuable source of data to assess any significant changes to upgradient groundwater quality that may impact water quality on the site.

The pit void waterbody has formed following cessation of mining, hydrogeological modelling suggests that the pit void water body has already reached its likely quasi steady state level (i.e. will not significantly increase in the future). Geochemical modelling results for the pit void water body suggest that some parameters (iron, manganese, ammonia and sulfate) will be higher than PAVs during and for a period post restoration, due to the dominant influence of groundwater on water quality. The suitability of PAVs for use as water quality targets for the pit void water requires review given the water body does not have direct connection to surface water bodies with established ecological function (and sensitive ecological receptors such as fish) and the ecological function of the water body itself has not been determined.

A dilution model, using a flowpath model based on the groundwater model to assess downstream impacts, indicates that the pit void waterbody is a relatively small fraction of the total at downstream receptor locations (including the groundwater leaving the site and the River Taff). Dilution calculations suggest that water quality risks from iron and phosphorous are not related to the pit void water quality but rather the baseline background water quality.

## **6 LIMITATIONS**

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This report was prepared under contract between Mine Environment Management Ltd. (MEM) and Merthyr (South Wales) Ltd (MWS).

The services undertaken by MEM in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the proposal agreed between MEM and MWS (document Ref:036/001/0324 dated the 8<sup>th</sup> March 2024). The opinions, conclusions and any recommendations in this report are based on information reviewed at the date of preparation of the report.

MEM has prepared this report on the basis of information provided to MEM by the Client and other companies engaged by the Client which MEM has not independently verified or checked beyond the agreed scope of work. MEM does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in provided information. Whilst every effort has been made to ensure the accuracy of the data supplied and any analysis interpretation derived from it, the possibility exists of variations in the ground and groundwater conditions around the site locations. No liability can be accepted for any such variations in these conditions. The opinions, conclusions and any recommendations in this report are based exclusively on information obtained from specific sampling and testing undertaken under supervision of MEM, and historical data collected by others as outlined within (in Section 2 and 3 of) this report.

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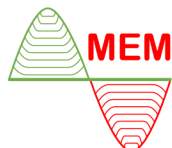
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# Appendix A

## Site Visit Memo



## Memorandum

|                     |                                                              |
|---------------------|--------------------------------------------------------------|
| <b>Project no</b>   | <b>036/01</b>                                                |
| <b>Date</b>         | <b>05/08/2024</b>                                            |
| <b>Subject</b>      | <b>July 2024 post site visit summary</b>                     |
| <b>Author</b>       | <b>P. McCann, J. Dent, S. Grant, S. Pearce (MEM)</b>         |
| <b>Distribution</b> | <b>C. Barber (Merthyr South Wales)<br/>J. Stoddard (RML)</b> |

This memorandum documents key findings and observations following the site visit to Ffos-y-Fran mine (the site) conducted by Sophie Grant and Phil McCann, both representing Mine Environment Management (MEM), on 11th July 2024. This was the first site visit by MEM staff to the site carried out to date. The main aims of the site visit were to meet the project team, inspect the current environmental management systems (relevant to acid and metalliferous mine drainage), observe mineralised waste character with respect to managing and mitigating acid and metalliferous drainage (AMD) risk. The emphasis of the visit was to assist with ongoing work being carried out by MEM to determine environmental risk with regards to development of an environmental impact assessment (EIA) for an approved closure plan.

Whilst the term acid and metalliferous drainage (AMD) is used in this document as a general term to describe mine water, it is likely (based on review of existing data) that mine impacted water at site is in general best characterised as neutral mine drainage.

### **Meetings held (11<sup>th</sup> July)**

An informal briefing was conducted by Chris Barber (Merthyr South Wales (MSW)) on arrival at site on the 11<sup>th</sup> July. The brief covered the site history, layout and current status of operations. In addition, Stuart Daley from Groundwater Science (GWS), was able to provide context and details regarding the water management issues. Questions were taken during the brief initial meeting. A short meeting was also held at the end of the day that summarised the discussions conducted during the visit.

*Table 1 meetings held*

| <b>Meeting title</b> | <b>Date</b> | <b>Attendees</b>   |
|----------------------|-------------|--------------------|
| Opening meeting      | 11 July     | CB, RP, PM, SG, SD |
| Close out meeting    | 11 July     | CB, PM, SG         |

Attendee details are provided below:

- PM: Phil McCann (MEM Senior Environmental Consultant)
- SG: Sophie Grant (MEM Senior Geoscientist)
- CB: Chris Barber (MSW Operations Manager)

- RP: Ron Phillips (MSW Ste Foreman)
- SD: Stuart Daley (Groundwater Science Principal Hydrogeologist)

After completing the site briefing, including the safety talk, both SG and PM, together with SD were taken on an escorted tour of selected areas of the site by CB and RP. The main (accessible) areas of the site were included; operational areas, Pit, Pit infill rehabilitation area, plateaux on OB1, toes of OB2 and OB3, plus several water treatment ponds. Time prevented inspections of GW (piezometer) and surface water sample points.

MSW allowed for photographs to be taken on the condition that they be used in documents relating to the project and not to be used on social media.

### **Key findings of site inspections and briefings**

- Old historic workings are suspected (and known) to exist within the mine boundary, but these are considered by the project team to be more of an issue for groundwater (GW) management. Given the area has been worked in the past and has been subject to a variety of historic anthropogenic activities (commercial and industrial), the result of these activities is likely had/having an impact on local water flows and quality.
- Several sites of importance for nature conservation (SINC) are near the site, but the project team is aware of no reported impacts on these sites from the operations that have been documented.
- Site inspection from Natural Resources Wales (NRW) have reduced over recent years, now to rare/sporadic visits. This suggests to MEM that NRW (in the capacity as the regulator) may not consider the site as a significant risk.
- Numerous pre-mining exploitation bores were drilled in the area, now under OB1 and OB2. The site team believe/are confident that they would have been capped prior to the OBs being constructed.
- Biffa operate a landfill site in an old open cast mine northeast of the main pit on the site. MSW have provided an ESI report which includes design information. Network of GW bores between Biffa landfill site and Mine site belong to Biffa. GWS and MSW team are understood to be following up on access to bores and or data. The boreholes were monitored until 2014 but have been dry for several years (potentially linked to the dewatering regime in the open pit).
- A historic landfill in an area/edge of first cuttings (pit) was removed prior to operations commencing. The area is defined on site mapping.
- Some areas of the site contained mine spoil tips at various times of operations, but this material has been removed. The tip areas were not lined.
- The material within the OBs and in-pit fill was described as homogenous and thus it is likely that they share similar properties and characteristics, regardless of location. During operations, the upper and lower seams were worked at the same time and the waste deposited to the same dumps, thereby “mixing” the waste material (Figure 1). It was noted that no block models or DTMs were developed. The initial excavated material was placed at OB1 and OB2. When enough space was available in the pit, MSW started backfilling within the pit, while progressing excavations further East. Material at OB3 was placed after pit backfilling.



*Figure 1 Backfill material in the pit*

- In 2014, coal washing commenced at MSW, with the higher ash coal being washed down to approximately 5% coal ash. Higher ash coal and the natural rock/slag/partings from the coal were also deposited into the backfill. This amounted to around 50,000 tonnes/year.
- Barrel washing was also carried out on site, with approximately 5 to 10% of residual coal (left in-situ during excavation), collected and sent through the barrel wash. Between 20 to 25% of the material collected was clean coal, and the remaining material (waste), went into the backfill. Still in place is a stockpile of barrel wash material (residual coal and waste). This will not be sent for washing now, so it will be mixed with the overburden material and placed back into the mine. This material represents a potential source of AMD.
- Two areas of inferior quality coal stockpiles/handling areas remain (ruminants). These contain high sulfur coal (~3-3.5% sulfur and high ash). The aim is to potentially sell these offsite, if this is not feasible, the material will be moved and placed/capped on the eastern side of the pit, thus any seepage and runoff will report to the pit void/lake (Figure 2). The potential impact for inclusion in any pit lake quality assessment will need to be determined by MEM.
- Silt from the settling ponds was removed every few years, mixed with the backfill material and deposited in OBs. Given the frequency of removal and likely volumes of sediment the potential AMD risk could be assessed as low.



Figure 2 Current location of high ash (inferior) coal, to possibly be mixed with the backfill and capped (TBD).

- The top 20m of material in OB1 will be pushed into the void as backfill during rehabilitation and reprofiling.
- Geology and hydrogeology – the rocks and seams are dipping south easterly. There are ~27 seams in total, with the 'B' seam being the lowest seam to be mined (a deeper 'A' seam was not mined due to depth). The groundwater flows south westerly (west side of mine) and easterly (overburden side of mine), with the latter potentially from deeper rocks. Between the 'A' and 'B' seams are ~5 ironstone horizons, which likely helped with drainage within the pit.
- During the last 12 months of mining, the front (void side) of OB1 slumped towards the pit. Near the end of mining, the final wall also failed, due to a fault (4m throw), behind the final wall (Figure 3). The area is scheduled for re-profiling. The area has been subjected to an updated geotechnical assessment.



Figure 3 Eastern wall fail and OB1 slumping

- Along the eastern edge of the pit, in the final wall, the 'R' seam, which contains 4% sulfur, is exposed. Staining can be seen above and below this seam, indicating seepages likely contain elevated levels of species such as iron that are liable to precipitate out of solution to form "coloured" secondary minerals (Figure 4).



*Figure 4 (top and bottom) Staining seen at seepages from 'R' seam.*

- A small area of potential AMD impacted surface water was observed within the pit (Figure 5). It was explained that a small high sulfur (4% sulfur) coal stockpile (G-lower) was stored in the pit (now removed), and the decolourisation was possibly the result of this material stockpiling. MEM understands that this area will be monitored (and/or cleaned up) to identify the nature of the impact and the source.



*Figure 5 AMD stream present in the pit.*

- It was suggested that some relevant geochemical data maybe contained within the EMMS (waste management plan). MEM agreed to follow-up with a review of the EMMS.
- An area that had been rehabilitated, approximately 18 months prior, was visited and a sample of the cover material taken. For the whole of site, the cover system design consists of ~0.35m of soil forming material (growth media) above the overburden. The soil forming material is a mix of overburden and soil scrapings, which is crushed in situ, to reduce any large material, to form a growth media (Figure 6).



*Figure 6 Rehabilitated area with soil forming material*

- Some previous rehabilitated areas had been re-vegetated via hydro seeding, but more recently, natural succession has been identified as the approach in achieving better medium to long term outcomes.
- From initial discussions with the project team on the cover system, MEM believe the cover system could be classified as an erosion protection cover system (Figure 7), in accordance with the Global Cover System Design (INAP, 2017<sup>1</sup>).

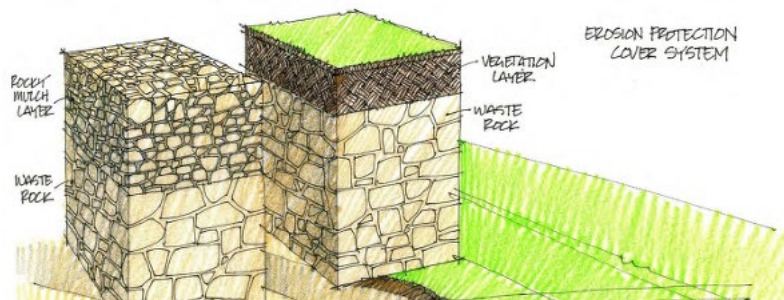


Figure 7 Cover classification (INAP, 2017)

- The flow of surface water around site was discussed in terms of management issues and erosion was not identified as a significant problem by the project team.
- Only minor seepage from the pit wall above the level of the pit lake was observed, mainly from the eastern pit wall, i.e. under OB1.
- A small surface water runoff stream was visible on OB1, but this likely drains into the pit void. It is likely that most surface/seepage water from OB1 drains into the pit void. A water sample is recommended by MEM to be taken from the identified stream to aid the drainage assessment of OB1 and the void.
- On OB2's plateau a pond of standing water was identified. No seepage areas were noted in and around OB2. MEM will request from CB where the underdrainage of OB2 likely reports to.
- No rehabilitation data was sighted (e.g. records), but from observations of the established areas to date, no specific issues or concerns were identified.
- During operations and currently, water treated on site is via sediment pond flow through system, before discharge. During operations, flocculant was added to coagulate sediment (to reduce suspended solids to within trigger and compliance limits). Since operations have ceased no flocculation has been required, and thus the sediment ponds are acting as a 'passive' system. The discharge limit for suspended solids was set as 50 ppm, and pH 5 – 9 and iron 3 mg/L. Discharge consent monitoring was completed 24/7 until 2015 and following that, monitoring was carried out three times a day until closure. Samples are still taken regularly during the closure period.
- With respect to reporting of water quality values only a minor number of non-compliance incidents occurred since operations commenced. At monitoring point MA6 – south of the site below OB3 – Mn, Mg and SO4 trigger limits (from the Discharge Consent) were exceeded infrequently. It was discussed by the project team that an investigation identified the weight of OB3 (possible dynamic loading) was resulting in "squeezing" out the contaminants under OB3 (historic workings – the high sulfur coal seams below OB3 were removed). A program including

<sup>1</sup> Global cover system design – Technical Guidance Document, International Network for Acid Prevention (INAP), November 2017

a macroinvertebrate study was conducted as part of these incidents and gave the 'all clear'. A copy of the study could be made available to MEM upon request.

- Shallow mining (20m deep) was conducted when the operation commenced, to remove high sulfur coal seams, in areas now under several of the OBs (before material placement). This includes an area near the southern edge of OB3. Interestingly, these historic workings coincide with an area of seepage at the toe of OB3. These areas are defined on site mapping.
- The lagoon system (WF) south of OB3, originally had an attenuation pond that leads to four settling ponds. The footprint of OB3 eventually grew to cover this attenuation pond. Since then, a new pond/sump has been 'dug out' to act as a collection pond for toe seepage (Figure 8), close to the original attenuation pond, that drains to the four settling ponds. The pond contains current runoff or seepage from OB3, or the underlying workings. The pond does not show any visible orange staining.



*Figure 8 Pond at the toe of OB3.*

- Within the settling ponds below this OB3 toe pond, orange staining was present (suggestive of precipitation of secondary iron bearing minerals). It was mainly seen at the northern end of the ponds (closest to OB3/attenuation pond) (Figure 9), with a higher concentration of staining present close to a leaking Penstock valve (inlet) (Figure 10). This Penstock valve originally fed the sediment ponds from the attenuation pond. The water from these settling ponds is discharged directly into the environment (outlet).



*Figure 9 Sediment ponds showing orange staining at northern end.*



*Figure 10 Concentration of orange staining around leaking Penstock valve.*

- Outside of the boundary of the settling ponds, a culvert with heavy orange staining was located (Figure 11). After discussions, it was thought this may have been the original attenuation overflow culvert. CB to investigate this further and identify if any sample results are available.



*Figure 11 Culvert with orange staining*

- MEM along with CB discussed a potential water sampling program, consisting of samples taken from the OB3 toe pond, the inlet to the settling ponds, the outlet, the culvert (potential overflow) and downstream of this culvert. A suggested overview of sample points for this monitoring is shown in Figure 12.



*Figure 12 Suggested water quality monitoring locations in OB3 ponds*

- MEM understands that quarterly sampling of boreholes on site and in the community is completed (with records from 2007 onwards). Some records are just water level monitoring, whilst others are also water quality sampling. Around six boreholes were in the pit area.
- If a reference or comparison site is required, it is understood that Celtic Energy completed rehab on a similar site in South Wales. The Celtic Energy site rehabilitation is reported to be approximately 5 years ahead of Ffos-Y-Fran.
- MEM and MSW briefly discussed the use of mining industry closure standards. MEM understands that MSW's primary requirement is to utilise standards and guidelines that meet requirements of the regulator. MEM recommended referencing relevant industry standards, even when not necessarily defined by the regulator. This approach would add credibility to any external stakeholder or organisation.
- Five material samples were taken (one sample of the in-pit fill material, one each from the material of the three OBs and a fifth from the cover material (growth media) and were received at the Geochemic laboratory in Pontypool. The laboratory will hold these samples until a request to analyse is received. The samples were due to arrive at the lab on the 12<sup>th</sup> July. An overview of the samples taken and the suggested analyses are provided in Table 2 and the sample logs attached to this memorandum. It is suggested that these samples are analysed for the suite as suggested in the table. This would provide some basic information on the geochemistry of the

material and support the AMD risk assessment for the site. An overview of sample locations is shown in Figure 13.



Figure 13 Backfill, overburden and SFM sample locations

Table 2 Overview of samples

| Sample | Location                        | Description                                                                                  | Suggested analyses                                                                   |
|--------|---------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| MS_1   | Backfill material from pit base | Grey, silty gravelly clay. Also includes traces of ironstone and fine coal gravels. Friable. | Total S and C<br>Sulfide S and TOC<br>Total metals suite (by ICP)<br>Rinse pH and EC |

| Sample | Location                                                 | Description                                                                                                                                                                                     | Suggested analyses                                                                   |
|--------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| MS_2   | Top of backfill/reclamation area – soil forming material | Dark grey to medium brown clayey gravel, with some ironstone. Mixed mine rocks in surrounding area. Occasional pockets of light brown orangey clay. More gravelly at 15-20 cm depth.            | Total S and C<br>Sulfide S and TOC<br>Total metals suite (by ICP)<br>Rinse pH and EC |
| MS_3   | OB1 material                                             | Dark grey silty gravelly clay, also some ironstone present. Ranges to a silty clayey gravel in a nearby location. In surrounding area were friable cobbles and fine gravel sized coal fragments | Total S and C<br>Sulfide S and TOC<br>Total metals suite (by ICP)<br>Rinse pH and EC |
| MS_4   | OB2 material                                             | Dark brownish grey silty gravel. Friable. Also contains ironstone gravels and occasionally fine gravel sized coal fragments. Occasional pockets of clay                                         | Total S and C<br>Sulfide S and TOC<br>Total metals suite (by ICP)<br>Rinse pH and EC |
| MS_5   | OB3 material                                             | Dark grey silty very gravelly clay. Some ironstone present. In surrounding area were cobbles and boulders of mine rocks. Friable.                                                               | Total S and C<br>Sulfide S and TOC<br>Total metals suite (by ICP)<br>Rinse pH and EC |

Overall, MEM observed the site to be tidy, organised. In addition, the impression was that the site was well maintained and resourced with staff and equipment. The site team seem to be proactive in engaging with closure activities; for example a dozer was observed to be conducting bench profiling during the visit.

### **Actions summary**

A full list of action items is provided in Table 3:

*Table 3 Action items*

| Item                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Who |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Request for information | MEM will submit any additional requests for information                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MEM |
| Material Analysis       | MEM will identify and provide costing from the laboratory to conduct the appropriate geochemical testing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | MEM |
| Water monitoring        | <p>Conduct a water quality monitoring program on the OB3 toes discharges. MEM have provided a figure attached with suggested monitoring locations. Monitoring can be a one off event initially. The water quality parameters should match that normally included for site monitoring including major cations and anions as well as metals.</p> <p>Include some water quality monitoring of drainage stream from OB1 into the pit void to provide information to aid in the pit void water quality assessment. As above the monitoring suite should match that normally used for the site including major cations and anions as well as metals.</p> <p>Provide information on where the underdrainage from OB2 reports to.</p> | MSW |

The data request is likely to be ongoing whilst the conceptual model is being developed and an update to any outstanding requests will be communicated by email.

Please do not hesitate to contact me at [jdent@memconsultants.co.uk](mailto:jdent@memconsultants.co.uk) should you have any questions or comments.

Julia Dent  
Senior Geoscientist  
[jdent@memconsultants.co.uk](mailto:jdent@memconsultants.co.uk)



# Appendix B

## Overburden, soil and soil forming material analysis results



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Plus Appendix Pages  
Finalized Date: 24-SEP-2024  
Account: GECHMI

## CERTIFICATE LR24241506

P.O. No.: GCLPO20240827-01

This report is for 5 samples of Rock submitted to our lab in Loughrea, Ireland on 30-AUG-2024.

The following have access to data associated with this certificate:

DATA AT GEOCHEMIC

## SAMPLE PREPARATION

| ALS CODE | DESCRIPTION                     |
|----------|---------------------------------|
| WEI-21   | Received Sample Weight          |
| LOG-22   | Sample login – Rcd w/o BarCode  |
| CRU-21   | Crush entire sample             |
| SPL-21   | Split sample – riffle splitter  |
| PUL-31   | Pulverize up to 250g 85% <75 um |
| BAG-01   | Bulk Master for Storage         |
| PUL-QC   | Pulverizing QC Test             |
| DRY-22   | Drying – Maximum Temp 60C       |

## ANALYTICAL PROCEDURES

| ALS CODE  | DESCRIPTION                              | INSTRUMENT |
|-----------|------------------------------------------|------------|
| ME-MS81   | Lithium Borate Fusion ICP-MS             | ICP-MS     |
| ME-MS42   | Up to 34 elements by ICP-MS              | ICP-MS     |
| ME-MS61   | 48 element four acid ICP-MS              |            |
| C-IR06a   | Non-Carbonate C by HCl Leach, Filter, IR | LECO       |
| S-IR06a   | Sulphide Sulphur by HCl Leach            | LECO       |
| OA-ELE07  | Paste pH                                 |            |
| ME-ICP06  | Whole Rock Package – ICP-AES             | ICP-AES    |
| TOT-ICP06 | Total Calculation for ICP06              |            |
| OA-GRA05  | Loss on Ignition at 1000C                | WST-SEQ    |
| C-IR07    | Total Carbon (IR Spectroscopy)           | LECO       |
| S-IR08    | Total Sulphur (IR Spectroscopy)          | LECO       |

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

\*\*\*\*\* See Appendix Page for comments regarding this certificate \*\*\*\*\*

Signature:

Andrey Tairov, Technical Manager, Ireland

\*\*\*\*\* See Appendix Page for comments regarding this certificate \*\*\*\*\*

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CERTIFICATE OF ANALYSIS LR24241506

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method:

REEs may not be totally soluble in this method.  
ME-MS61

ACCREDITATION COMMENTS

Applies to Method:

The methods immediately below this line are ISO 17025:2017 Accredited. INAB Registration No: 173T  
C-IR07 ME-ICP06 ME-MS61  
OA-GRA05 S-IR08

ME-MS81



LABORATORY ADDRESSES

Applies to Method:

Processed at ALS Loughrea located at Dublin Road, Loughrea, Co. Galway, Ireland.

BAG-01  
DRY-22  
ME-MS61  
PUL-31  
SPL-21

C-IR06a  
LOG-22  
ME-MS81  
PUL-QC  
TOT-ICP06

C-IR07  
ME-ICP06  
OA-ELE07  
S-IR06a  
WEI-21

CRU-21  
ME-MS42  
OA-GRA05  
S-IR08



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DATA AT GEOCHEMIC

## SAMPLE PREPARATION

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| PUL-31   | Pulverize up to 250g 85% <75 um |
| BAG-01   | Bulk Master for Storage         |
| PUL-QC   | Pulverizing QC Test             |
| DRY-22   | Drying – Maximum Temp 60C       |

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| ME-MS61   | 48 element four acid ICP-MS              |            |
| C-IR06a   | Non-Carbonate C by HCl Leach, Filter, IR | LECO       |
| S-IR06a   | Sulphide Sulphur by HCl Leach            | LECO       |
| OA-ELE07  | Paste pH                                 |            |
| ME-ICP06  | Whole Rock Package – ICP-AES             | ICP-AES    |
| TOT-ICP06 | Total Calculation for ICP06              |            |
| OA-GRA05  | Loss on Ignition at 1000C                | WST-SEQ    |
| C-IR07    | Total Carbon (IR Spectroscopy)           | LECO       |
| S-IR08    | Total Sulphur (IR Spectroscopy)          | LECO       |

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

\*\*\*\*\* See Appendix Page for comments regarding this certificate \*\*\*\*\*

Signature:

Andrey Tairov, Technical Manager, Ireland



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | TOT-ICP06 | OA-GRA05 |
|----------------------------|-----------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|----------|
|                            |                                   | SiO2     | Al2O3    | Fe2O3    | CaO      | MgO      | Na2O     | K2O      | Cr2O3    | TiO2     | MnO      | P2O5     | SrO      | BaO      | Total     | LOI      |
|                            |                                   | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %         | %        |
|                            |                                   | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.002    | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.01      | 0.01     |
| STANDARDS                  |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| AMIS0353                   |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           | 1.95     |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           | 1.81     |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           | 2.03     |
| AMIS0356                   |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           | 20.5     |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           | 19.20    |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           | 21.2     |
| EMOG-17                    |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| GGC-09                     |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| GGC-11                     |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| GGC-11                     |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| GGC-11                     |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| GS910-4                    |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| GS914-5                    |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| MRGeo08                    |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| MRGeo08                    |                                   | 63.7     | 15.20    | 5.93     | 3.80     | 2.37     | 2.74     | 3.85     | 0.016    | 0.84     | 0.08     | 0.24     | 0.03     | 0.13     | 98.93     |          |
| Target Range – Lower Bound |                                   | 61.0     | 14.50    | 5.66     | 3.62     | 2.24     | 2.52     | 3.67     | 0.009    | 0.79     | 0.05     | 0.21     | <0.01    | 0.10     |           |          |
| Upper Bound                |                                   | 63.8     | 15.50    | 6.16     | 3.98     | 2.50     | 2.80     | 4.03     | 0.021    | 0.93     | 0.11     | 0.27     | 0.06     | 0.15     |           |          |
| NCSDC60120                 |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| OREAS-45f                  |                                   |          |          |          |          |          |          |          |          |          |          |          |          |          |           |          |



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | C-IR07 | S-IR08 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 | ME-MS81 |
|----------------------------|-----------------------------------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                            |                                   | C      | S      | Ba      | Ce      | Cr      | Cs      | Dy      | Er      | Eu      | Ga      | Gd      | Ge      | Hf      | Ho      |
|                            |                                   | %      | %      | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     | ppm     |
|                            |                                   | 0.01   | 0.01   | 0.5     | 0.1     | 5       | 0.01    | 0.05    | 0.03    | 0.02    | 0.1     | 0.05    | 0.5     | 0.05    | 0.01    |
| STANDARDS                  |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| AMIS0353                   |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| AMIS0356                   |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| EMOG-17                    |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| GGC-09                     |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| GGC-11                     |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| GGC-11                     |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| GGC-11                     |                                   | 5.23   | 3.68   |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   | 4.87   | 3.59   |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   | 5.25   | 3.87   |         |         |         |         |         |         |         |         |         |         |         |         |
| GS910-4                    |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| GS914-5                    |                                   | 1.39   | 1.07   |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   | 1.33   | 1.03   |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   | 1.45   | 1.13   |         |         |         |         |         |         |         |         |         |         |         |         |
| MRGeo08                    |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| MRGeo08                    |                                   |        |        | 1035    | 78.1    | 116     | 11.35   | 4.93    | 2.80    | 1.39    | 20.2    | 5.46    | 1.5     | 8.09    | 0.98    |
| Target Range – Lower Bound |                                   |        |        | 988     | 71.2    | 99      | 11.25   | 4.67    | 2.67    | 1.29    | 17.8    | 5.26    | <0.5    | 6.70    | 0.90    |
| Upper Bound                |                                   |        |        | 1210    | 87.2    | 132     | 13.75   | 5.81    | 3.33    | 1.62    | 22.0    | 6.54    | 1.0     | 8.30    | 1.12    |
| NCSDC60120                 |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Target Range – Lower Bound |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| Upper Bound                |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |
| OREAS-45f                  |                                   |        |        |         |         |         |         |         |         |         |         |         |         |         |         |



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Account: GECHMI

QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Lu<br>ppm<br>0.01 | ME-MS81<br>Nb<br>ppm<br>0.05 | ME-MS81<br>Nd<br>ppm<br>0.1 | ME-MS81<br>Pr<br>ppm<br>0.02 | ME-MS81<br>Rb<br>ppm<br>0.2 | ME-MS81<br>Sm<br>ppm<br>0.03 | ME-MS81<br>Sn<br>ppm<br>0.5 | ME-MS81<br>Sr<br>ppm<br>0.1 | ME-MS81<br>Ta<br>ppm<br>0.1 | ME-MS81<br>Tb<br>ppm<br>0.01 | ME-MS81<br>Th<br>ppm<br>0.05 | ME-MS81<br>Tm<br>ppm<br>0.01 | ME-MS81<br>U<br>ppm<br>0.05 | ME-MS81<br>V<br>ppm<br>5 | ME-MS81<br>W<br>ppm<br>0.5 |
|----------------------------|-----------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|--------------------------|----------------------------|
| STANDARDS                  |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| AMIS0353                   |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| AMIS0356                   |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| EMOG-17                    |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| GGC-09                     |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| GGC-11                     |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| GGC-11                     |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| GGC-11                     |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| GS910-4                    |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| GS914-5                    |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| MRGeo08                    |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| MRGeo08                    |                                   | 0.44                         | 22.4                         | 33.3                        | 8.96                         | 208                         | 6.72                         | 3.6                         | 294                         | 1.6                         | 0.83                         | 20.5                         | 0.39                         | 5.70                        | 116                      | 5.6                        |
| Target Range - Lower Bound |                                   | 0.36                         | 19.05                        | 31.2                        | 8.35                         | 192.5                       | 6.00                         | 3.1                         | 277                         | 1.3                         | 0.80                         | 19.20                        | 0.38                         | 5.58                        | 98                       | 3.7                        |
| Upper Bound                |                                   | 0.46                         | 23.4                         | 38.4                        | 10.25                        | 236                         | 7.40                         | 5.5                         | 339                         | 1.8                         | 1.00                         | 23.6                         | 0.48                         | 6.94                        | 130                      | 6.2                        |
| NCSDC60120                 |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| OREAS-45f                  |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Y<br>ppm<br>0.1 | ME-MS81<br>Yb<br>ppm<br>0.03 | ME-MS81<br>Zr<br>ppm<br>1 | ME-MS42<br>As<br>ppm<br>0.1 | ME-MS42<br>Bi<br>ppm<br>0.01 | ME-MS42<br>Hg<br>ppm<br>0.005 | ME-MS42<br>In<br>ppm<br>0.005 | ME-MS42<br>Re<br>ppm<br>0.001 | ME-MS42<br>Sb<br>ppm<br>0.05 | ME-MS42<br>Se<br>ppm<br>0.2 | ME-MS42<br>Te<br>ppm<br>0.01 | ME-MS42<br>Tl<br>ppm<br>0.02 | ME-MS61<br>Ag<br>ppm<br>0.01 | ME-MS61<br>Cd<br>ppm<br>0.02 | ME-MS61<br>Co<br>ppm<br>0.1 |
|----------------------------|-----------------------------------|----------------------------|------------------------------|---------------------------|-----------------------------|------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|
| STANDARDS                  |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| AMIS0353                   |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| AMIS0356                   |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| EMOG-17                    |                                   |                            |                              |                           | >250                        | 5.90                         | 0.527                         | 0.876                         | 0.314                         | >250                         | 6.7                         | 1.34                         | 2.03                         |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           | 522                         | 5.32                         | 0.463                         | 0.814                         | 0.287                         | 574                          | 5.5                         | 1.18                         | 1.71                         |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           | >250                        | 6.52                         | 0.638                         | 1.005                         | 0.353                         | >250                         | 7.2                         | 1.46                         | 2.37                         |                              |                              |                             |
| GGC-09                     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| GGC-11                     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| GGC-11                     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| GGC-11                     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| GS910-4                    |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| GS914-5                    |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| MRGeo08                    |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              | 4.28                         | 2.13                         | 19.8                        |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              | 3.93                         | 2.00                         | 17.7                        |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              | 4.83                         | 2.48                         | 21.9                        |
| MRGeo08                    |                                   | 27.6                       | 2.62                         | 319                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   | 25.4                       | 2.39                         | 263                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   | 31.2                       | 2.99                         | 323                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| NCSDC60120                 |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| OREAS-45f                  |                                   |                            |                              |                           | 2.9                         | 0.15                         | 0.030                         | 0.089                         | <0.001                        | 0.24                         | 0.5                         | 0.04                         | 0.11                         |                              |                              |                             |



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS61<br>Cu<br>ppm<br>0.2 | ME-MS61<br>Li<br>ppm<br>0.2 | ME-MS61<br>Mo<br>ppm<br>0.05 | ME-MS61<br>Ni<br>ppm<br>0.2 | ME-MS61<br>Pb<br>ppm<br>0.5 | ME-MS61<br>Sc<br>ppm<br>0.1 | ME-MS61<br>Zn<br>ppm<br>2 | C-IR06a<br>C organi<br>%<br>0.01 | S-IR06a<br>Sulphide<br>%<br>0.01 | OA-ELE07<br>pH<br>Unity<br>0.1 |
|----------------------------|-----------------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|----------------------------------|----------------------------------|--------------------------------|
| STANDARDS                  |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| AMIS0353                   |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| AMIS0356                   |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| EMOG-17                    |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| GGC-09                     |                                   |                             |                             |                              |                             |                             |                             |                           | 2.42                             |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           | 2.10                             |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           | 2.58                             |                                  |                                |
| GGC-11                     |                                   |                             |                             |                              |                             |                             |                             |                           | 4.30                             |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           | 4.13                             |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           | 5.07                             |                                  |                                |
| GGC-11                     |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 2.70                             |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 2.59                             |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 3.19                             |                                |
| GGC-11                     |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| GS910-4                    |                                   |                             |                             |                              |                             |                             |                             |                           | 0.05                             |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           | 0.04                             |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           | 0.08                             |                                  |                                |
| GS914-5                    |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| MRGeo08                    |                                   | 635                         | 33.0                        | 16.00                        | 691                         | 1080                        | 12.4                        | 811                       |                                  |                                  |                                |
| Target Range – Lower Bound |                                   | 587                         | 29.5                        | 13.65                        | 622                         | 971                         | 11.1                        | 722                       |                                  |                                  |                                |
| Upper Bound                |                                   | 675                         | 36.5                        | 16.75                        | 760                         | 1185                        | 13.7                        | 886                       |                                  |                                  |                                |
| MRGeo08                    |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| NCSDC60120                 |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 2.13                             |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 1.79                             |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 2.21                             |                                |
| OREAS-45f                  |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |



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Page: 3 - A  
Total # Pages: 5 (A - E)  
Plus Appendix Pages  
Finalized Date: 24-SEP-2024  
Account: GECHMI

QC CERTIFICATE OF ANALYSIS LR24241506

|                            | Method<br>Analyte<br>Units<br>LOD | ME-ICP06<br>SiO2<br>% | ME-ICP06<br>Al2O3<br>% | ME-ICP06<br>Fe2O3<br>% | ME-ICP06<br>CaO<br>% | ME-ICP06<br>MgO<br>% | ME-ICP06<br>Na2O<br>% | ME-ICP06<br>K2O<br>% | ME-ICP06<br>Cr2O3<br>% | ME-ICP06<br>TiO2<br>% | ME-ICP06<br>MnO<br>% | ME-ICP06<br>P2O5<br>% | ME-ICP06<br>SrO<br>% | ME-ICP06<br>BaO<br>% | TOT-ICP06<br>Total<br>% | OA-GRA05<br>LOI<br>% |
|----------------------------|-----------------------------------|-----------------------|------------------------|------------------------|----------------------|----------------------|-----------------------|----------------------|------------------------|-----------------------|----------------------|-----------------------|----------------------|----------------------|-------------------------|----------------------|
| Sample Description         |                                   | 0.01                  | 0.01                   | 0.01                   | 0.01                 | 0.01                 | 0.01                  | 0.01                 | 0.002                  | 0.01                  | 0.01                 | 0.01                  | 0.01                 | 0.01                 | 0.01                    | 0.01                 |
| STANDARDS                  |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| OREAS-45f                  |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| REE-1                      |                                   | 68.2                  | 6.87                   | 6.04                   | 3.32                 | 1.50                 | 1.98                  | 3.82                 | 0.041                  | 0.65                  | 0.22                 | 0.07                  | 0.01                 | 0.01                 | 92.73                   |                      |
| Target Range – Lower Bound |                                   | 65.6                  | 6.50                   | 5.70                   | 3.11                 | 1.39                 | 1.83                  | 3.54                 | 0.032                  | 0.58                  | 0.17                 | 0.04                  | <0.01                | <0.01                |                         |                      |
| Upper Bound                |                                   | 68.6                  | 7.06                   | 6.20                   | 3.43                 | 1.57                 | 2.06                  | 3.90                 | 0.048                  | 0.70                  | 0.23                 | 0.08                  | 0.02                 | 0.03                 |                         |                      |
| SILICA                     |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANKS                     |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         | 0.00                 |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         | <0.01                |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         | 0.02                 |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| BLANK                      |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Target Range – Lower Bound |                                   |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |
| Upper Bound                | </                                |                       |                        |                        |                      |                      |                       |                      |                        |                       |                      |                       |                      |                      |                         |                      |



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Page: 3 – B  
Total # Pages: 5 (A – E)  
Plus Appendix Pages  
Finalized Date: 24-SEP-2024  
Account: GECHMI

QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | C-IR07<br>C<br>% | S-IR08<br>S<br>% | ME-MS81<br>Ba<br>ppm | ME-MS81<br>Ce<br>ppm | ME-MS81<br>Cr<br>ppm | ME-MS81<br>Cs<br>ppm | ME-MS81<br>Dy<br>ppm | ME-MS81<br>Er<br>ppm | ME-MS81<br>Eu<br>ppm | ME-MS81<br>Ga<br>ppm | ME-MS81<br>Gd<br>ppm | ME-MS81<br>Ge<br>ppm | ME-MS81<br>Hf<br>ppm | ME-MS81<br>Ho<br>ppm | ME-MS81<br>La<br>ppm |
|----------------------------|-----------------------------------|------------------|------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                            |                                   | 0.01             | 0.01             | 0.5                  | 0.1                  | 5                    | 0.01                 | 0.05                 | 0.03                 | 0.02                 | 0.1                  | 0.05                 | 0.5                  | 0.05                 | 0.01                 | 0.1                  |
| STANDARDS                  |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| OREAS-45f                  |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| REE-1                      |                                   |                  |                  | 96.2                 | 3810                 | 293                  | 0.96                 | 843                  | 692                  | 22.3                 | 49.1                 | 416                  | 7.0                  | 521                  | 206                  | 1555                 |
| Target Range – Lower Bound |                                   |                  |                  | 89.6                 | 3560                 | 244                  | 0.95                 | 762                  | 631                  | 21.1                 | 48.1                 | 390                  | 5.3                  | 431                  | 187.0                | 1495                 |
| Upper Bound                |                                   |                  |                  | 110.5                | 4360                 | 310                  | 1.19                 | 932                  | 771                  | 25.9                 | 59.0                 | 476                  | 7.9                  | 527                  | 229                  | 1825                 |
| SILICA                     |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANKS                     |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   | <0.01            | <0.01            |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   | <0.01            | <0.01            |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   | 0.02             | 0.02             |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| BLANK                      |                                   |                  |                  | <0.5                 | <0.1                 | <5                   | <0.01                | <0.05                | <0.03                | <0.02                | 0.1                  | <0.05                | <0.5                 | <0.05                | <0.01                | <0.1                 |
| BLANK                      |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |



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Page: 3 - C  
Total # Pages: 5 (A - E)  
Plus Appendix Pages  
Finalized Date: 24-SEP-2024  
Account: GECHMI

QC CERTIFICATE OF ANALYSIS LR24241506

|                            | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Lu<br>ppm<br>0.01 | ME-MS81<br>Nb<br>ppm<br>0.05 | ME-MS81<br>Nd<br>ppm<br>0.1 | ME-MS81<br>Pr<br>ppm<br>0.02 | ME-MS81<br>Rb<br>ppm<br>0.2 | ME-MS81<br>Sm<br>ppm<br>0.03 | ME-MS81<br>Sn<br>ppm<br>0.5 | ME-MS81<br>Sr<br>ppm<br>0.1 | ME-MS81<br>Ta<br>ppm<br>0.1 | ME-MS81<br>Tb<br>ppm<br>0.01 | ME-MS81<br>Th<br>ppm<br>0.05 | ME-MS81<br>Tm<br>ppm<br>0.01 | ME-MS81<br>U<br>ppm<br>0.05 | ME-MS81<br>V<br>ppm<br>5 | ME-MS81<br>W<br>ppm<br>0.5 |
|----------------------------|-----------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|--------------------------|----------------------------|
| Sample Description         | STANDARDS                         |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Upper Bound                       |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | OREAS-45f                         |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Upper Bound                       |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | REE-1                             | 93.2                         | >2500                        | 1455                        | 439                          | 978                         | 386                          | 484                         | 119.0                       | 236                         | 106.0                        | 708                          | 108.0                        | 137.0                       | 6                        | 8.7                        |
|                            | Target Range – Lower Bound        | 83.2                         | 3640                         | 1310                        | 391                          | 942                         | 343                          | 448                         | 116.0                       | 208                         | 95.6                         | 666                          | 95.4                         | 123.5                       | <5                       | 6.9                        |
|                            | Upper Bound                       | 101.5                        | >2500                        | 1600                        | 479                          | 1150                        | 419                          | 548                         | 142.0                       | 254                         | 117.0                        | 814                          | 116.5                        | 151.0                       | 20                       | 9.7                        |
|                            | SILICA                            |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Upper Bound                       |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | BLANKS                            |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | BLANK                             |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | BLANK                             |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Upper Bound                       |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | BLANK                             |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Upper Bound                       |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | BLANK                             |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Upper Bound                       |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | BLANK                             |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            | Target Range – Lower Bound        |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| BLANK                      |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range – Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |

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## QC CERTIFICATE OF ANALYSIS LR24241506

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## QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS61<br>Cu<br>ppm<br>0.2 | ME-MS61<br>Li<br>ppm<br>0.2 | ME-MS61<br>Mo<br>ppm<br>0.05 | ME-MS61<br>Ni<br>ppm<br>0.2 | ME-MS61<br>Pb<br>ppm<br>0.5 | ME-MS61<br>Sc<br>ppm<br>0.1 | ME-MS61<br>Zn<br>ppm<br>2 | C-IR06a<br>C organi<br>%<br>0.01 | S-IR06a<br>Sulphide<br>%<br>0.01 | OA-ELE07<br>pH<br>Unity<br>0.1 |
|----------------------------|-----------------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|----------------------------------|----------------------------------|--------------------------------|
| STANDARDS                  |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| OREAS-45f                  |                                   | 363                         | 20.6                        | 2.22                         | 261                         | 14.2                        | 37.0                        | 36                        |                                  |                                  |                                |
| Target Range – Lower Bound |                                   | 337                         | 18.2                        | 1.99                         | 230                         | 12.7                        | 32.6                        | 30                        |                                  |                                  |                                |
| Upper Bound                |                                   | 389                         | 22.6                        | 2.55                         | 282                         | 16.7                        | 40.0                        | 41                        |                                  |                                  |                                |
| REE-1                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| SILICA                     |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 7.0                            |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 6.6                            |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 8.3                            |
| BLANKS                     |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           | <0.01                            |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           | <0.01                            |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           | <0.01                            |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           | 0.02                             |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| BLANK                      |                                   | 0.3                         | <0.2                        | <0.05                        | 0.4                         | <0.5                        | <0.1                        | 2                         |                                  |                                  |                                |
| Target Range – Lower Bound |                                   | <0.2                        | <0.2                        | <0.05                        | <0.2                        | <0.5                        | <0.1                        | <2                        |                                  |                                  |                                |
| Upper Bound                |                                   | 0.4                         | 0.4                         | 0.10                         | 0.4                         | 1.0                         | 0.2                         | 4                         |                                  |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | <0.01                            |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | <0.01                            |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | <0.01                            |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.02                             |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| BLANK                      |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description                                           | Method<br>Analyte<br>Units<br>LOD | ME-ICP06<br>SiO2<br>%        | ME-ICP06<br>Al2O3<br>%           | ME-ICP06<br>Fe2O3<br>%       | ME-ICP06<br>CaO<br>%         | ME-ICP06<br>MgO<br>%         | ME-ICP06<br>Na2O<br>%        | ME-ICP06<br>K2O<br>%         | ME-ICP06<br>Cr2O3<br>%            | ME-ICP06<br>TiO2<br>%        | ME-ICP06<br>MnO<br>%         | ME-ICP06<br>P2O5<br>%        | ME-ICP06<br>SrO<br>%         | ME-ICP06<br>BaO<br>%         | TOT-ICP06<br>Total<br>% | OA-GRA05<br>LOI<br>%             |
|--------------------------------------------------------------|-----------------------------------|------------------------------|----------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-------------------------|----------------------------------|
|                                                              |                                   | 0.01                         | 0.01                             | 0.01                         | 0.01                         | 0.01                         | 0.01                         | 0.01                         | 0.002                             | 0.01                         | 0.01                         | 0.01                         | 0.01                         | 0.01                         | 0.01                    | 0.01                             |
| ORIGINAL<br>DUP<br>Target Range - Lower Bound<br>Upper Bound |                                   | DUPLICATES                   |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         |                                  |
| ORIGINAL<br>DUP<br>Target Range - Lower Bound<br>Upper Bound |                                   | 68.4<br>68.9<br>66.9<br>70.4 | 14.55<br>14.60<br>14.20<br>14.95 | 3.21<br>3.24<br>3.13<br>3.32 | 1.80<br>1.83<br>1.76<br>1.87 | 1.18<br>1.19<br>1.15<br>1.22 | 3.83<br>3.86<br>3.74<br>3.95 | 3.60<br>3.57<br>3.49<br>3.68 | 0.003<br>0.003<br><0.002<br>0.004 | 0.34<br>0.35<br>0.33<br>0.36 | 0.06<br>0.06<br>0.05<br>0.07 | 0.10<br>0.10<br>0.09<br>0.11 | 0.03<br>0.03<br>0.02<br>0.04 | 0.11<br>0.11<br>0.10<br>0.12 |                         |                                  |
| ORIGINAL<br>DUP<br>Target Range - Lower Bound<br>Upper Bound |                                   |                              |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         | 2.81<br>2.66<br>2.66<br>2.81     |
| MS_1<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                              |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         | 12.20<br>12.10<br>11.85<br>12.45 |
| MS_2<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                              |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         |                                  |
| MS_3<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                              |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         |                                  |
| MS_4<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                              |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         |                                  |
| MS_5<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                              |                                  |                              |                              |                              |                              |                              |                                   |                              |                              |                              |                              |                              |                         |                                  |



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## QC CERTIFICATE OF ANALYSIS LR24241506

|                                                              | Method<br>Analyte<br>Units<br>LOD | C-IR07<br>C<br>%<br>0.01     | S-IR08<br>S<br>%<br>0.01     | ME-MS81<br>Ba<br>ppm<br>0.5 | ME-MS81<br>Ce<br>ppm<br>0.1  | ME-MS81<br>Cr<br>ppm<br>5 | ME-MS81<br>Cs<br>ppm<br>0.01 | ME-MS81<br>Dy<br>ppm<br>0.05 | ME-MS81<br>Er<br>ppm<br>0.03 | ME-MS81<br>Eu<br>ppm<br>0.02 | ME-MS81<br>Ga<br>ppm<br>0.1  | ME-MS81<br>Gd<br>ppm<br>0.05 | ME-MS81<br>Ge<br>ppm<br>0.5 | ME-MS81<br>Hf<br>ppm<br>0.05 | ME-MS81<br>Ho<br>ppm<br>0.01 | ME-MS81<br>La<br>ppm<br>0.1  |
|--------------------------------------------------------------|-----------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   | DUPLICATES                   |                              |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   |                              |                              | 947<br>911<br>882<br>976    | 37.6<br>36.5<br>35.1<br>39.0 | 18<br>19<br>13<br>24      | 2.01<br>1.90<br>1.85<br>2.06 | 1.32<br>1.26<br>1.18<br>1.40 | 0.85<br>0.90<br>0.80<br>0.95 | 0.40<br>0.36<br>0.34<br>0.42 | 18.5<br>16.8<br>16.7<br>18.6 | 1.32<br>1.20<br>1.15<br>1.37 | 0.9<br>0.9<br><0.5<br>1.0   | 4.27<br>4.19<br>3.97<br>4.49 | 0.28<br>0.25<br>0.24<br>0.29 | 20.1<br>19.1<br>18.5<br>20.7 |
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   |                              |                              |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |
| MS_1<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   | 3.77<br>3.78<br>3.67<br>3.88 | 0.07<br>0.07<br>0.06<br>0.08 |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |
| MS_2<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |
| MS_3<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   | 6.34<br>6.19<br>6.10<br>6.43 | 0.26<br>0.25<br>0.24<br>0.27 |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |
| MS_4<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |
| MS_5<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                             |                              |                           |                              |                              |                              |                              |                              |                              |                             |                              |                              |                              |



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## QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description                                           | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Lu<br>ppm<br>0.01 | ME-MS81<br>Nb<br>ppm<br>0.05 | ME-MS81<br>Nd<br>ppm<br>0.1  | ME-MS81<br>Pr<br>ppm<br>0.02 | ME-MS81<br>Rb<br>ppm<br>0.2      | ME-MS81<br>Sm<br>ppm<br>0.03 | ME-MS81<br>Sn<br>ppm<br>0.5 | ME-MS81<br>Sr<br>ppm<br>0.1 | ME-MS81<br>Ta<br>ppm<br>0.1 | ME-MS81<br>Tb<br>ppm<br>0.01 | ME-MS81<br>Th<br>ppm<br>0.05 | ME-MS81<br>Tm<br>ppm<br>0.01 | ME-MS81<br>U<br>ppm<br>0.05  | ME-MS81<br>V<br>ppm<br>5 | ME-MS81<br>W<br>ppm<br>0.5 |
|--------------------------------------------------------------|-----------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|----------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|--------------------------|----------------------------|
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   | DUPLICATES                   |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   | 0.18<br>0.17<br>0.16<br>0.19 | 9.10<br>8.46<br>8.29<br>9.27 | 12.5<br>12.2<br>11.6<br>13.1 | 3.88<br>3.66<br>3.56<br>3.98 | 127.5<br>122.0<br>118.5<br>131.0 | 2.14<br>1.90<br>1.89<br>2.15 | 0.7<br>1.0<br><0.5<br>1.0   | 272<br>260<br>253<br>279    | 1.0<br>1.0<br>0.9<br>1.2    | 0.22<br>0.20<br>0.19<br>0.23 | 25.5<br>23.2<br>23.1<br>25.6 | 0.15<br>0.14<br>0.13<br>0.16 | 6.77<br>6.47<br>6.24<br>7.00 | 57<br>57<br>49<br>65     | 3.1<br>3.0<br>2.4<br>3.7   |
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   |                              |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |
| MS_1<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |
| MS_2<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |
| MS_3<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |
| MS_4<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |
| MS_5<br>DUP<br>Target Range – Lower Bound<br>Upper Bound     |                                   |                              |                              |                              |                              |                                  |                              |                             |                             |                             |                              |                              |                              |                              |                          |                            |



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## QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description                                           | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Y<br>ppm<br>0.1 | ME-MS81<br>Yb<br>ppm<br>0.03 | ME-MS81<br>Zr<br>ppm<br>1 | ME-MS42<br>As<br>ppm<br>0.1 | ME-MS42<br>Bi<br>ppm<br>0.01 | ME-MS42<br>Hg<br>ppm<br>0.005 | ME-MS42<br>In<br>ppm<br>0.005 | ME-MS42<br>Re<br>ppm<br>0.001 | ME-MS42<br>Sb<br>ppm<br>0.05 | ME-MS42<br>Se<br>ppm<br>0.2 | ME-MS42<br>Te<br>ppm<br>0.01 | ME-MS42<br>Tl<br>ppm<br>0.02 | ME-MS61<br>Ag<br>ppm<br>0.01 | ME-MS61<br>Cd<br>ppm<br>0.02 | ME-MS61<br>Co<br>ppm<br>0.1 |
|--------------------------------------------------------------|-----------------------------------|----------------------------|------------------------------|---------------------------|-----------------------------|------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|
| ORIGINAL<br>DUP<br>Target Range - Lower Bound<br>Upper Bound |                                   | DUPLICATES                 |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              | 0.08<br>0.09<br>0.07<br>0.10 | 0.28<br>0.28<br>0.25<br>0.31 | 497<br>491<br>469<br>519    |
| ORIGINAL<br>DUP<br>Target Range - Lower Bound<br>Upper Bound |                                   | 8.7<br>8.1<br>7.9<br>8.9   | 1.09<br>0.97<br>0.95<br>1.11 | 149<br>154<br>143<br>160  |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| ORIGINAL<br>DUP<br>Target Range - Lower Bound<br>Upper Bound |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| MS_1<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| MS_2<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| MS_3<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| MS_4<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| MS_5<br>DUP<br>Target Range - Lower Bound<br>Upper Bound     |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |



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**QC CERTIFICATE OF ANALYSIS LR24241506**

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS61<br>Cu<br>ppm<br>0.2 | ME-MS61<br>Li<br>ppm<br>0.2 | ME-MS61<br>Mo<br>ppm<br>0.05 | ME-MS61<br>Ni<br>ppm<br>0.2 | ME-MS61<br>Pb<br>ppm<br>0.5 | ME-MS61<br>Sc<br>ppm<br>0.1 | ME-MS61<br>Zn<br>ppm<br>2 | C-IR06a<br>C organi<br>%<br>0.01 | S-IR06a<br>Sulphide<br>%<br>0.01 | OA-ELE07<br>pH<br>Unity<br>0.1 |
|----------------------------|-----------------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|----------------------------------|----------------------------------|--------------------------------|
| DUPLICATES                 |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| ORIGINAL                   |                                   | 50.0                        | 18.4                        | 0.88                         | 4070                        | 8.1                         | 28.1                        | 176                       |                                  |                                  |                                |
| DUP                        |                                   | 50.0                        | 18.2                        | 0.92                         | 4040                        | 8.0                         | 28.1                        | 175                       |                                  |                                  |                                |
| Target Range – Lower Bound |                                   | 48.1                        | 17.2                        | 0.81                         | 3850                        | 7.1                         | 26.6                        | 165                       |                                  |                                  |                                |
| Upper Bound                |                                   | 52.0                        | 19.4                        | 1.00                         | 4260                        | 9.0                         | 29.6                        | 186                       |                                  |                                  |                                |
| ORIGINAL                   |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| ORIGINAL                   |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| MS_1                       |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 7.7                            |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 7.7                            |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 7.2                            |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  | 8.2                            |
| MS_2                       |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.02                             |                                |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.02                             |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | <0.01                            |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.03                             |                                |
| MS_3                       |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| MS_4                       |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.04                             |                                |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.04                             |                                |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.03                             |                                |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           |                                  | 0.05                             |                                |
| MS_5                       |                                   |                             |                             |                              |                             |                             |                             |                           | 6.26                             |                                  | 6.2                            |
| DUP                        |                                   |                             |                             |                              |                             |                             |                             |                           | 6.24                             |                                  | 6.2                            |
| Target Range – Lower Bound |                                   |                             |                             |                              |                             |                             |                             |                           | 5.93                             |                                  | 5.8                            |
| Upper Bound                |                                   |                             |                             |                              |                             |                             |                             |                           | 6.57                             |                                  | 6.6                            |



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| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-ICP06   | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | ME-ICP06 | TOT-ICP06 | OA-GRA05 |
|----------------------------|-----------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|----------|
|                            |                                   | SiO2       | Al2O3    | Fe2O3    | CaO      | MgO      | Na2O     | K2O      | Cr2O3    | TiO2     | MnO      | P2O5     | SrO      | BaO      | Total     | LOI      |
|                            |                                   | %          | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %        | %         | %        |
|                            |                                   | 0.01       | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.002    | 0.01     | 0.01     | 0.01     | 0.01     | 0.01     | 0.01      | 0.01     |
|                            |                                   | DUPLICATES |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| ORIGINAL                   |                                   | 72.3       | 13.60    | 2.86     | 3.77     | 0.74     | 2.96     | 1.89     | 0.002    | 0.47     | 0.06     | 0.12     | 0.02     | 0.05     |           |          |
| DUP                        |                                   | 72.0       | 13.55    | 2.85     | 3.79     | 0.74     | 2.96     | 1.88     | 0.002    | 0.47     | 0.06     | 0.12     | 0.02     | 0.05     |           |          |
| Target Range – Lower Bound |                                   | 70.3       | 13.25    | 2.77     | 3.68     | 0.71     | 2.88     | 1.83     | <0.002   | 0.45     | 0.05     | 0.11     | <0.01    | 0.04     |           |          |
| Upper Bound                |                                   | 74.0       | 13.90    | 2.94     | 3.88     | 0.77     | 3.04     | 1.94     | 0.004    | 0.49     | 0.07     | 0.13     | 0.03     | 0.06     |           |          |
| ORIGINAL                   |                                   |            |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| DUP                        |                                   |            |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Target Range – Lower Bound |                                   |            |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
| Upper Bound                |                                   |            |          |          |          |          |          |          |          |          |          |          |          |          |           |          |
|                            |                                   |            |          |          |          |          |          |          |          |          |          |          |          |          |           |          |



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| Sample Description         | Method<br>Analyte<br>Units<br>LOD | C-IR07<br>C<br>% | S-IR08<br>S<br>% | ME-MS81<br>Ba<br>ppm | ME-MS81<br>Ce<br>ppm | ME-MS81<br>Cr<br>ppm | ME-MS81<br>Cs<br>ppm | ME-MS81<br>Dy<br>ppm | ME-MS81<br>Er<br>ppm | ME-MS81<br>Eu<br>ppm | ME-MS81<br>Ga<br>ppm | ME-MS81<br>Gd<br>ppm | ME-MS81<br>Ge<br>ppm | ME-MS81<br>Hf<br>ppm | ME-MS81<br>Ho<br>ppm | ME-MS81<br>La<br>ppm |
|----------------------------|-----------------------------------|------------------|------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                            |                                   | 0.01             | 0.01             | 0.5                  | 0.1                  | 5                    | 0.01                 | 0.05                 | 0.03                 | 0.02                 | 0.1                  | 0.05                 | 0.5                  | 0.05                 | 0.01                 | 0.1                  |
| ORIGINAL                   |                                   |                  |                  | 414                  | 45.2                 | 9                    | 0.17                 | 3.17                 | 1.88                 | 0.97                 | 19.8                 | 3.66                 | 1.1                  | 3.91                 | 0.68                 | 21.4                 |
| DUP                        |                                   |                  |                  | 401                  | 42.9                 | 9                    | 0.21                 | 2.98                 | 1.98                 | 0.95                 | 18.6                 | 3.53                 | 0.9                  | 3.73                 | 0.66                 | 20.2                 |
| Target Range – Lower Bound |                                   |                  |                  | 387                  | 41.7                 | <5                   | 0.17                 | 2.87                 | 1.80                 | 0.89                 | 18.1                 | 3.37                 | <0.5                 | 3.58                 | 0.63                 | 19.7                 |
| Upper Bound                |                                   |                  |                  | 428                  | 46.4                 | 10                   | 0.21                 | 3.28                 | 2.06                 | 1.03                 | 20.3                 | 3.82                 | 1.6                  | 4.06                 | 0.71                 | 21.9                 |
| ORIGINAL                   |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| DUP                        |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Target Range – Lower Bound |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
| Upper Bound                |                                   |                  |                  |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Lu<br>ppm<br>0.01 | ME-MS81<br>Nb<br>ppm<br>0.05 | ME-MS81<br>Nd<br>ppm<br>0.1 | ME-MS81<br>Pr<br>ppm<br>0.02 | ME-MS81<br>Rb<br>ppm<br>0.2 | ME-MS81<br>Sm<br>ppm<br>0.03 | ME-MS81<br>Sn<br>ppm<br>0.5 | ME-MS81<br>Sr<br>ppm<br>0.1 | ME-MS81<br>Ta<br>ppm<br>0.1 | ME-MS81<br>Tb<br>ppm<br>0.01 | ME-MS81<br>Th<br>ppm<br>0.05 | ME-MS81<br>Tm<br>ppm<br>0.01 | ME-MS81<br>U<br>ppm<br>0.05 | ME-MS81<br>V<br>ppm<br>5 | ME-MS81<br>W<br>ppm<br>0.5 |
|----------------------------|-----------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|--------------------------|----------------------------|
| DUPLICATES                 |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| ORIGINAL                   |                                   | 0.30                         | 6.60                         | 21.9                        | 5.45                         | 21.4                        | 4.49                         | 1.2                         | 237                         | 0.4                         | 0.57                         | 3.47                         | 0.27                         | 1.84                        | 47                       | 1.4                        |
| DUP                        |                                   | 0.29                         | 6.38                         | 20.7                        | 5.15                         | 20.8                        | 4.29                         | 0.8                         | 226                         | 0.4                         | 0.50                         | 3.31                         | 0.28                         | 1.78                        | 45                       | 1.3                        |
| Target Range - Lower Bound |                                   | 0.27                         | 6.12                         | 20.1                        | 5.02                         | 19.8                        | 4.14                         | <0.5                        | 220                         | 0.3                         | 0.50                         | 3.17                         | 0.25                         | 1.67                        | 39                       | 0.8                        |
| Upper Bound                |                                   | 0.32                         | 6.86                         | 22.5                        | 5.59                         | 22.4                        | 4.64                         | 1.6                         | 243                         | 0.5                         | 0.57                         | 3.61                         | 0.30                         | 1.95                        | 53                       | 1.9                        |
| ORIGINAL                   |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| DUP                        |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Target Range - Lower Bound |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
| Upper Bound                |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |
|                            |                                   |                              |                              |                             |                              |                             |                              |                             |                             |                             |                              |                              |                              |                             |                          |                            |



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| Sample Description         | Method<br>Analyte<br>Units<br>LOD | ME-MS81<br>Y<br>ppm<br>0.1 | ME-MS81<br>Yb<br>ppm<br>0.03 | ME-MS81<br>Zr<br>ppm<br>1 | ME-MS42<br>As<br>ppm<br>0.1 | ME-MS42<br>Bi<br>ppm<br>0.01 | ME-MS42<br>Hg<br>ppm<br>0.005 | ME-MS42<br>In<br>ppm<br>0.005 | ME-MS42<br>Re<br>ppm<br>0.001 | ME-MS42<br>Sb<br>ppm<br>0.05 | ME-MS42<br>Se<br>ppm<br>0.2 | ME-MS42<br>Te<br>ppm<br>0.01 | ME-MS42<br>Tl<br>ppm<br>0.02 | ME-MS61<br>Ag<br>ppm<br>0.01 | ME-MS61<br>Cd<br>ppm<br>0.02 | ME-MS61<br>Co<br>ppm<br>0.1 |
|----------------------------|-----------------------------------|----------------------------|------------------------------|---------------------------|-----------------------------|------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|
| DUPLICATES                 |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| ORIGINAL                   |                                   | 17.2                       | 1.85                         | 149                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| DUP                        |                                   | 17.5                       | 1.80                         | 143                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Target Range - Lower Bound |                                   | 16.4                       | 1.70                         | 138                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| Upper Bound                |                                   | 18.3                       | 1.95                         | 154                       |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |
| ORIGINAL                   |                                   |                            |                              |                           | 0.6                         | 0.14                         | 0.005                         | 0.009                         | 0.001                         | <0.05                        | 0.2                         | 0.01                         | 0.05                         |                              |                              |                             |
| DUP                        |                                   |                            |                              |                           | 0.6                         | 0.14                         | <0.005                        | 0.007                         | <0.001                        | <0.05                        | 0.2                         | 0.01                         | 0.05                         |                              |                              |                             |
| Target Range - Lower Bound |                                   |                            |                              |                           | 0.5                         | 0.12                         | <0.005                        | <0.005                        | <0.001                        | <0.05                        | <0.2                        | <0.01                        | 0.03                         |                              |                              |                             |
| Upper Bound                |                                   |                            |                              |                           | 0.7                         | 0.16                         | 0.010                         | 0.010                         | 0.002                         | 0.10                         | 0.4                         | 0.02                         | 0.07                         |                              |                              |                             |
|                            |                                   |                            |                              |                           |                             |                              |                               |                               |                               |                              |                             |                              |                              |                              |                              |                             |



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QC CERTIFICATE OF ANALYSIS LR24241506

| Sample Description                                           | Method<br>Analyte<br>Units<br>LOD | ME-MS61<br>Cu<br>ppm<br>0.2 | ME-MS61<br>Li<br>ppm<br>0.2 | ME-MS61<br>Mo<br>ppm<br>0.05 | ME-MS61<br>Ni<br>ppm<br>0.2 | ME-MS61<br>Pb<br>ppm<br>0.5 | ME-MS61<br>Sc<br>ppm<br>0.1 | ME-MS61<br>Zn<br>ppm<br>2 | C-IR06a<br>C organi<br>%<br>0.01 | S-IR06a<br>Sulphide<br>%<br>0.01 | OA-ELE07<br>pH<br>Unity<br>0.1 |
|--------------------------------------------------------------|-----------------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|----------------------------------|----------------------------------|--------------------------------|
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   | DUPLICATES                  |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
| ORIGINAL<br>DUP<br>Target Range – Lower Bound<br>Upper Bound |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |
|                                                              |                                   |                             |                             |                              |                             |                             |                             |                           |                                  |                                  |                                |



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UNITED KINGDOM

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QC CERTIFICATE OF ANALYSIS LR24241506

## CERTIFICATE COMMENTS

### ANALYTICAL COMMENTS

Applies to Method: REEs may not be totally soluble in this method.  
ME-MS61

### ACCREDITATION COMMENTS

Applies to Method: The methods immediately below this line are ISO 17025:2017 Accredited. INAB Registration No: 173T  
C-IR07 ME-ICP06 ME-MS61 ME-MS81  
OA-GRA05 S-IR08



### LABORATORY ADDRESSES

Applies to Method: Processed at ALS Loughrea located at Dublin Road, Loughrea, Co. Galway, Ireland.  
BAG-01 C-IR06a C-IR07 CRU-21  
DRY-22 LOG-22 ME-ICP06 ME-MS42  
ME-MS61 ME-MS81 OA-ELE07 OA-GRA05  
PUL-31 PUL-QC S-IR06a S-IR08  
SPL-21 TOT-ICP06 WEI-21



# Appendix C

## Water quality: Statistics and Time series graphs



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## 1 MONITORING POINTS

Table 1 Monitoring point summary

| Code                | Description/location                   | Water type        |
|---------------------|----------------------------------------|-------------------|
| MA1                 | Nant Morlais                           | Culvert - Inlet   |
| MA2                 | CEL Z1                                 | Culvert - Inlet   |
| MA3                 | CEL Z - Nant Morlais                   | Culvert - Outfall |
| MA4                 | Pen Yr Heol                            | Culvert           |
| MA5                 | WA                                     | Discharge Point   |
| MA6                 | Bargod Taf                             | Culvert           |
| MA7                 | Nant Gyrawd - Upstream of Bargod Taf   | River             |
| MA8                 | Bargod Taf - Downstream of Nant Gyrawd | River             |
| MA9                 | Upstream of Rhymney Culvert            | Culvert           |
| MA10                | Pontlloftyn Bridge                     | River             |
| MA11                | Rhaslas                                | Pond              |
| MA12                | Blaencarno                             |                   |
| MA13                | Nant Llesg Tributaries                 | River             |
| MA14                | Ponlloftyn Tributaries                 | River             |
| MA15                | Nant Bargoed Rhymni (lower)            | River             |
| MA16                | Nant Bargoed Rhymni (upper)            | River             |
| Mine                | In-pit Lake                            | Mine GW           |
| Mine - Ground Water | In-pit Sump                            | Mine GW           |
| Mine Hole           | In-pit Sump                            | Mine GW           |
| Mine WB             | In-pit Flow into Sump                  | Mine GW           |
| NL100               | Observation Well                       | GW                |
| NL169               | Observation Well                       | GW                |
| NL170               | Observation Well                       | GW                |
| NL175               | Observation Well                       | GW                |
| NL186               | Observation Well                       | GW                |
| NL192               | Observation Well                       | GW                |
| SC1                 | Observation Well                       | GW                |
| SC2                 | Observation Well                       | GW                |
| WB                  | NRW Discharge Point                    | Discharge Point   |
| WC1                 | NRW Discharge Point                    | Discharge Point   |
| WI                  | NRW Discharge Point                    | Discharge Point   |
| GW1                 | Trecatti landfill boreholes            | GW                |
| GW2                 | Trecatti landfill boreholes            | GW                |
| GW3                 | Trecatti landfill boreholes            | GW                |
| GW4                 | Trecatti landfill boreholes            | GW                |
| GW5                 | Trecatti landfill boreholes            | GW                |
| GW6                 | Trecatti landfill boreholes            | GW                |



| Code                 | Description/location        | Water type         |
|----------------------|-----------------------------|--------------------|
| <b>GW7</b>           | Trecatti landfill boreholes | GW                 |
| <b>GW8</b>           | Trecatti landfill boreholes | GW                 |
| <b>GW9</b>           | Trecatti landfill boreholes | GW                 |
| <b>GW10</b>          | Trecatti landfill boreholes | GW                 |
| <b>GW11</b>          | Trecatti landfill boreholes | GW                 |
| <b>GW12</b>          | Trecatti landfill boreholes | GW                 |
| <b>Dowlais Fault</b> | Dowlais Fault               | Dowlais fault (GW) |
| <b>DP Discharge</b>  | Dowlais Fault discharge     | Dowlais fault (GW) |
| <b>5808</b>          | Observation Well            | GW                 |
| <b>5812</b>          | Observation Well            | GW                 |
| <b>5824</b>          | Observation Well            | GW                 |
| <b>5808A</b>         | Observation Well            | GW                 |
| <b>BF</b>            | River                       | River              |

## 2 CULVERT

Table 2 Culvert Monitoring Point Statistics

| Parameter    | Units | Stat  | MA04  | MA06      | MA09     |
|--------------|-------|-------|-------|-----------|----------|
| Al           | mg/l  | min   | 0.03  | 0         | 0.01     |
|              |       | max   | 0.06  | 0.64      | 0.89     |
|              |       | mean  | 0.045 | 0.0616    | 0.071    |
|              |       | count | 2     | 163       | 107      |
| Alkalinity   | mg/l  | min   | 170   | 5         | 30       |
|              |       | max   | 191   | 375       | 1660     |
|              |       | mean  | 180.5 | 214.0064  | 116.251  |
|              |       | count | 2     | 157       | 100      |
| As           | mg/l  | min   | 0.01  | 0.0003    | 0.0004   |
|              |       | max   | 0.01  | 0.01      | 0.01     |
|              |       | mean  | 0.01  | 0.0013    | 0.0015   |
|              |       | count | 1     | 141       | 80       |
| Ca           | mg/l  | min   | 75    | 9         | 8        |
|              |       | max   | 84    | 231       | 96       |
|              |       | mean  | 79.5  | 124.596   | 31.486   |
|              |       | count | 2     | 165       | 109      |
| Cd           | mg/l  | min   | 0.002 | 0.00002   | 0        |
|              |       | max   | 0.002 | 0.002     | 0.002    |
|              |       | mean  | 0.002 | 0.00025   | 0.00037  |
|              |       | count | 2     | 142       | 81       |
| Cl           | mg/l  | min   | 15    | 4         | 5        |
|              |       | max   | 21    | 67        | 128      |
|              |       | mean  | 18    | 9.994     | 20.139   |
|              |       | count | 2     | 164       | 108      |
| Conductivity | mS/cm | min   | 580   | 0.697     | 0.135    |
|              |       | max   | 792   | 2100      | 1060     |
|              |       | mean  | 686   | 1166.9401 | 308.6725 |
|              |       | count | 2     | 159       | 103      |
| Cr           | mg/l  | min   | 0.01  | 0         | 0.001    |
|              |       | max   | 0.01  | 0.0218    | 0.0116   |
|              |       | mean  | 0.01  | 0.001736  | 0.001908 |
|              |       | count | 1     | 141       | 80       |
| Cu           | mg/l  | min   | 0.01  | 0         | 0        |
|              |       | max   | 0.01  | 0.025     | 0.012    |
|              |       | mean  | 0.01  | 0.00381   | 0.00466  |
|              |       | count | 2     | 165       | 108      |
| Fe           | mg/l  | min   | 0.03  | 0         | 0.005    |
|              |       | max   | 0.03  | 15.5      | 4.64     |
|              |       | mean  | 0.03  | 0.4057    | 0.3395   |
|              |       | count | 1     | 164       | 108      |
| Hg           | mg/l  | min   | 0.001 | 0.00003   | 0.00003  |
|              |       | max   | 0.001 | 0.001     | 0.001    |
|              |       | mean  | 0.001 | 0.0001    | 0.00011  |
|              |       | count | 1     | 141       | 80       |
| K            | mg/l  | min   | 13    | 1         | 1        |
|              |       | max   | 19    | 155       | 36       |
|              |       | mean  | 16    | 29.932    | 5.11     |
|              |       | count | 2     | 165       | 109      |
| Mg           | mg/l  | min   | 23    | 2         | 2        |
|              |       | max   | 50    | 191       | 69       |
|              |       | mean  | 36.5  | 101.492   | 13.138   |
|              |       | count | 2     | 165       | 109      |



| Parameter        | Units    | Stat  | MA04   | MA06     | MA09    |
|------------------|----------|-------|--------|----------|---------|
| Mn               | mg/l     | min   | 0.01   | 0.007    | 0.001   |
|                  |          | max   | 0.023  | 4.813    | 0.514   |
|                  |          | mean  | 0.0165 | 0.62815  | 0.04421 |
|                  |          | count | 2      | 150      | 101     |
| Mo               | mg/l     | min   | 0      | 0.001    | 0.001   |
|                  |          | max   | 0      | 0.765    | 0.076   |
|                  |          | mean  | 0      | 0.00831  | 0.00336 |
|                  |          | count | 0      | 139      | 77      |
| N                | mg/l     | min   | 0.5    | 0        | 0       |
|                  |          | max   | 0.5    | 2.7      | 36.2    |
|                  |          | mean  | 0.5    | 0.4217   | 1.0716  |
|                  |          | count | 2      | 151      | 102     |
| NH3 (as N)       | mg/l     | min   | 0.1    | 0        | 0       |
|                  |          | max   | 0.1    | 23       | 0.7     |
|                  |          | mean  | 0.1    | 0.278    | 0.149   |
|                  |          | count | 2      | 165      | 109     |
| Na               | mg/l     | min   | 19     | 5        | 3       |
|                  |          | max   | 21     | 69       | 66      |
|                  |          | mean  | 20     | 18.44    | 13.69   |
|                  |          | count | 2      | 165      | 109     |
| Ni               | mg/l     | min   | 0.002  | 0        | 0       |
|                  |          | max   | 0.002  | 0.268    | 0.577   |
|                  |          | mean  | 0.002  | 0.02807  | 0.01065 |
|                  |          | count | 2      | 142      | 81      |
| Pb               | mg/l     | min   | 0.005  | 0.0002   | 0       |
|                  |          | max   | 0.005  | 99.5     | 0.007   |
|                  |          | mean  | 0.005  | 0.60524  | 0.00294 |
|                  |          | count | 2      | 165      | 108     |
| SO4              | mg/l     | min   | 140    | 11       | 1       |
|                  |          | max   | 232    | 1070     | 258     |
|                  |          | mean  | 186    | 542.3939 | 38.9633 |
|                  |          | count | 2      | 165      | 109     |
| Se               | mg/l     | min   | 0.003  | 0        | 0.0001  |
|                  |          | max   | 0.003  | 0.012    | 0.008   |
|                  |          | mean  | 0.003  | 0.00325  | 0.00139 |
|                  |          | count | 1      | 158      | 102     |
| Suspended Solids | mg/l     | min   | 7      | 2        | 2       |
|                  |          | max   | 7      | 249      | 52      |
|                  |          | mean  | 7      | 14.406   | 8.505   |
|                  |          | count | 2      | 165      | 109     |
| Zn               | mg/l     | min   | 0.01   | 0        | 0       |
|                  |          | max   | 0.013  | 0.134    | 0.07    |
|                  |          | mean  | 0.0115 | 0.0152   | 0.01311 |
|                  |          | count | 2      | 164      | 108     |
| pH               | pH units | min   | 8.1    | 7        | 7       |
|                  |          | max   | 8.2    | 10.7     | 8.6     |
|                  |          | mean  | 8.15   | 7.8018   | 7.67    |
|                  |          | count | 2      | 166      | 110     |

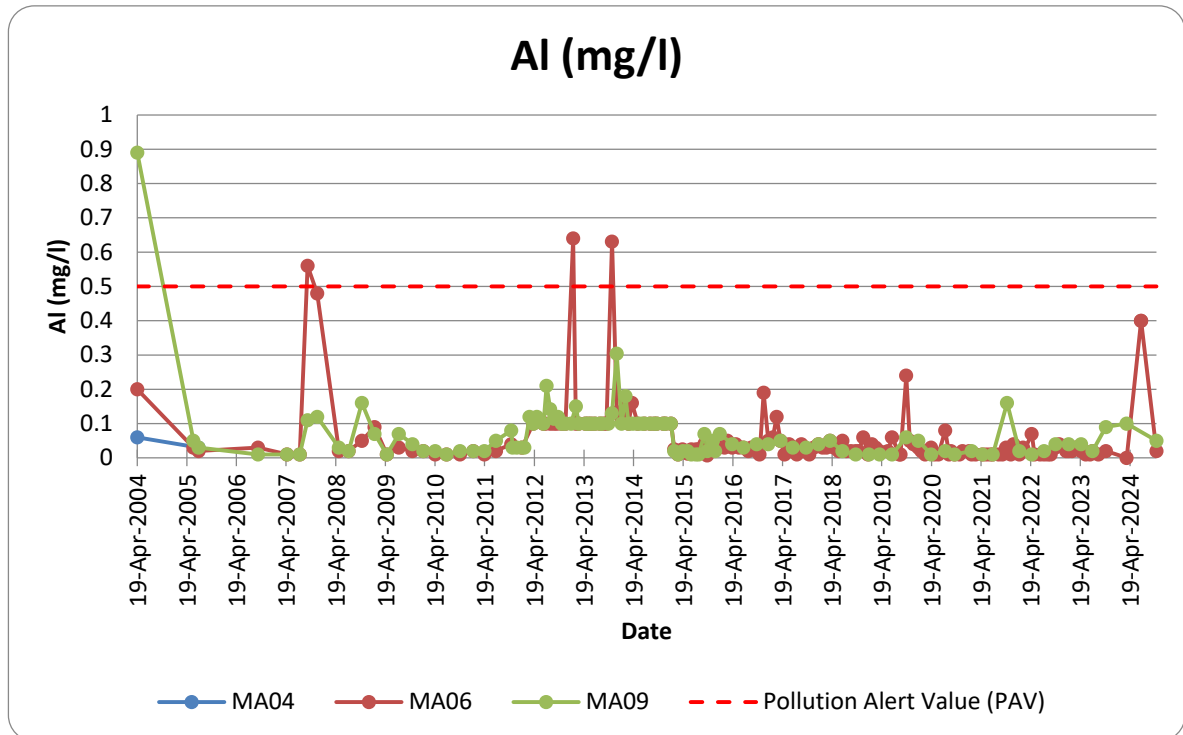


Figure 1: Al Concentration timeseries within the Culvert

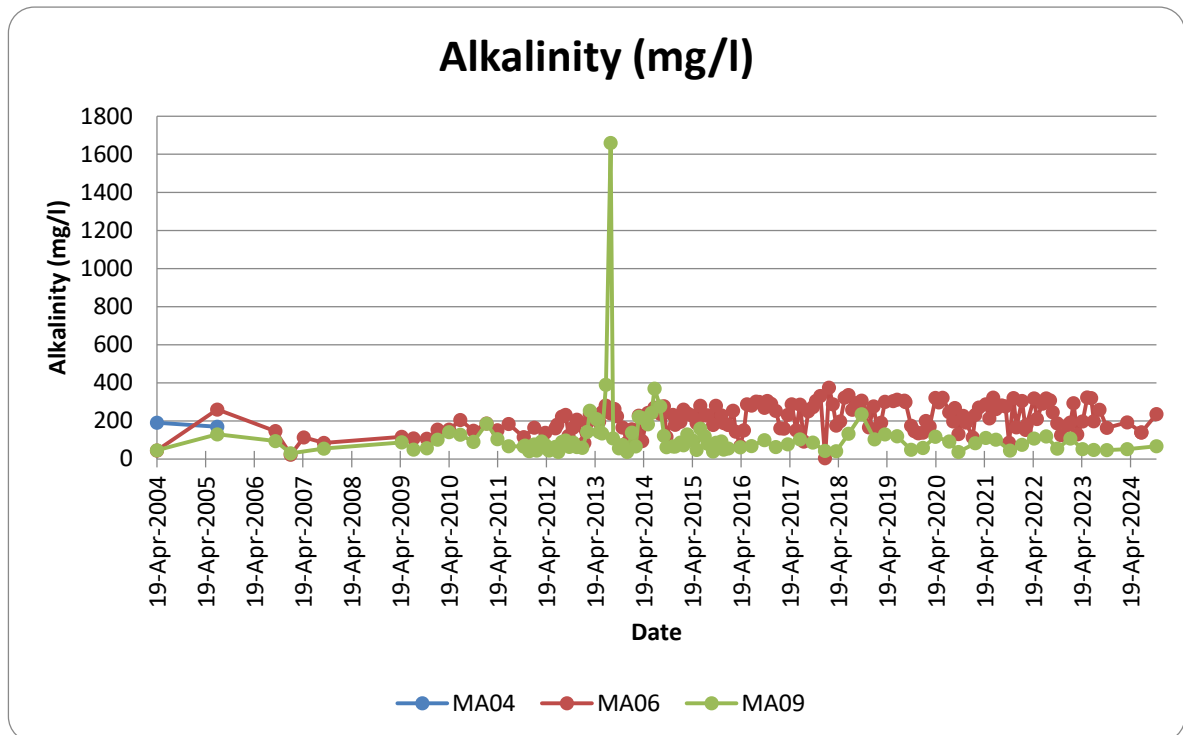


Figure 2: Alkalinity Concentration timeseries within the Culvert

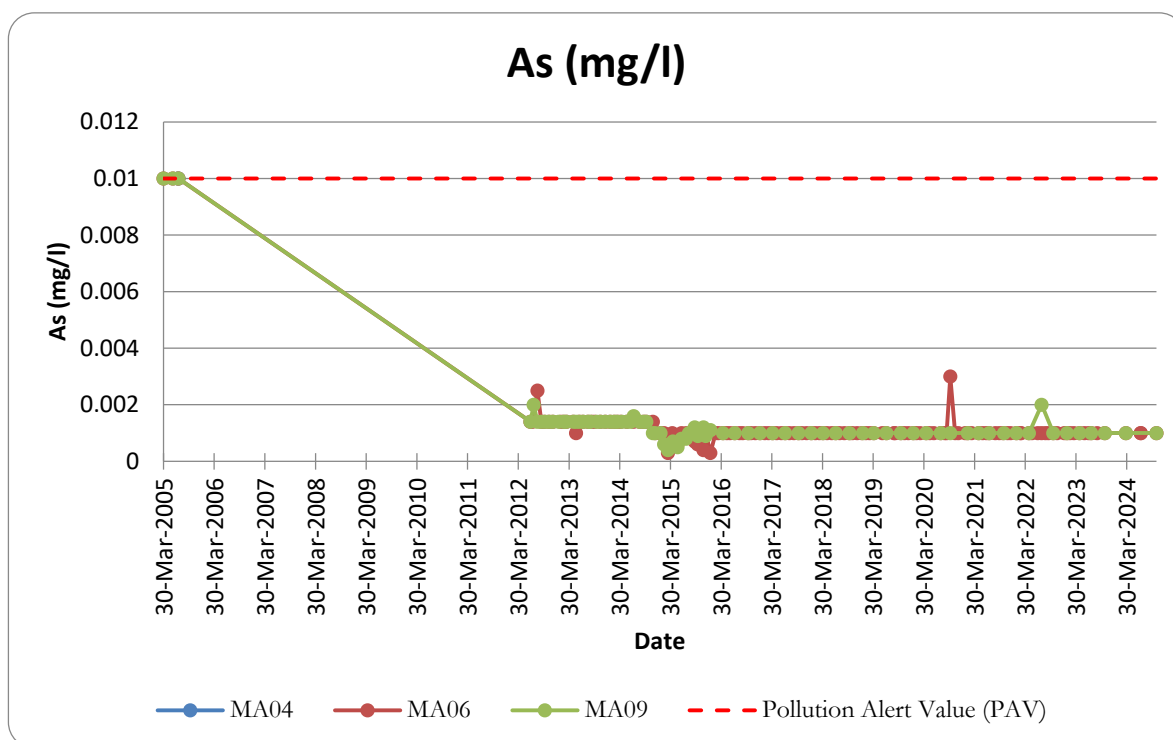


Figure 3: As Concentration timeseries within the Culvert

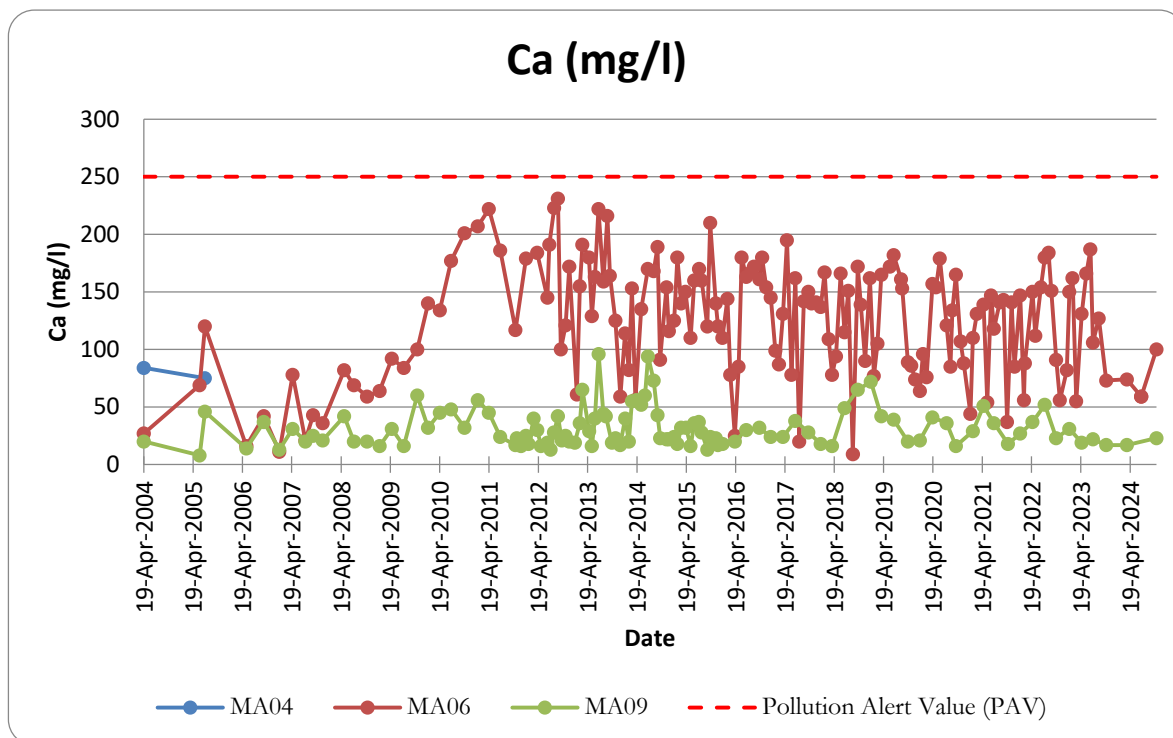


Figure 4: Ca Concentration timeseries within the Culvert

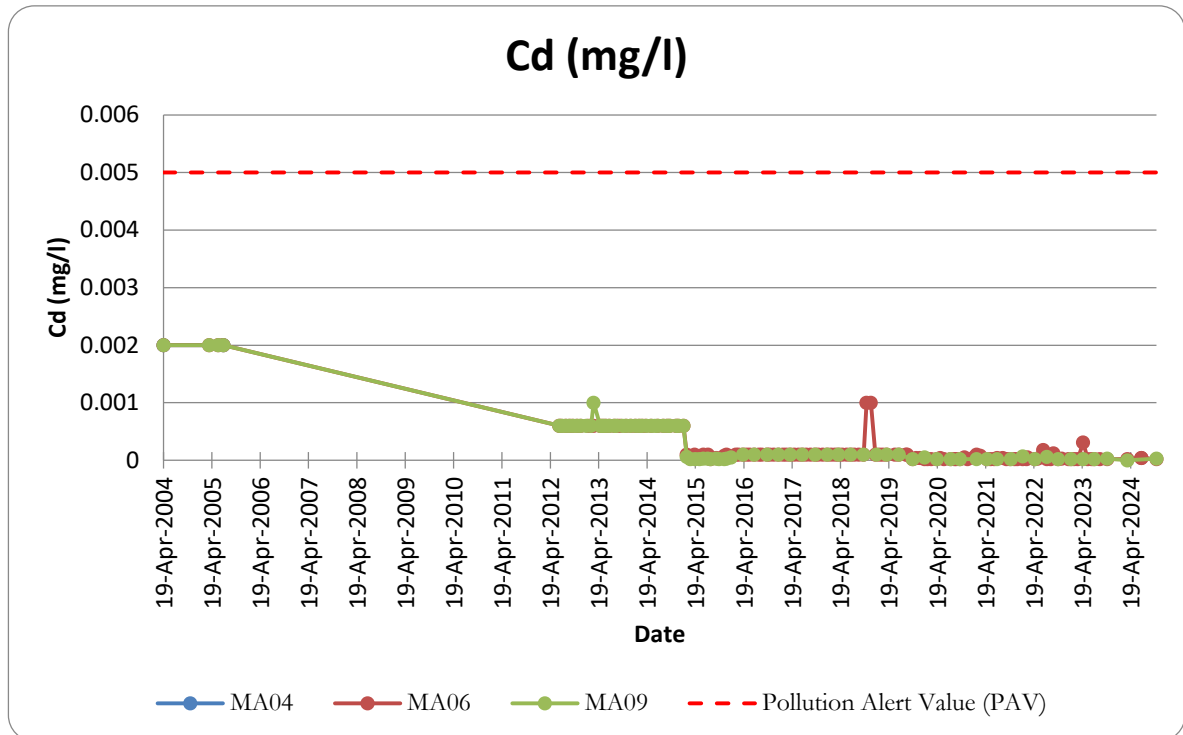


Figure 5: Cd Concentration timeseries within the Culvert

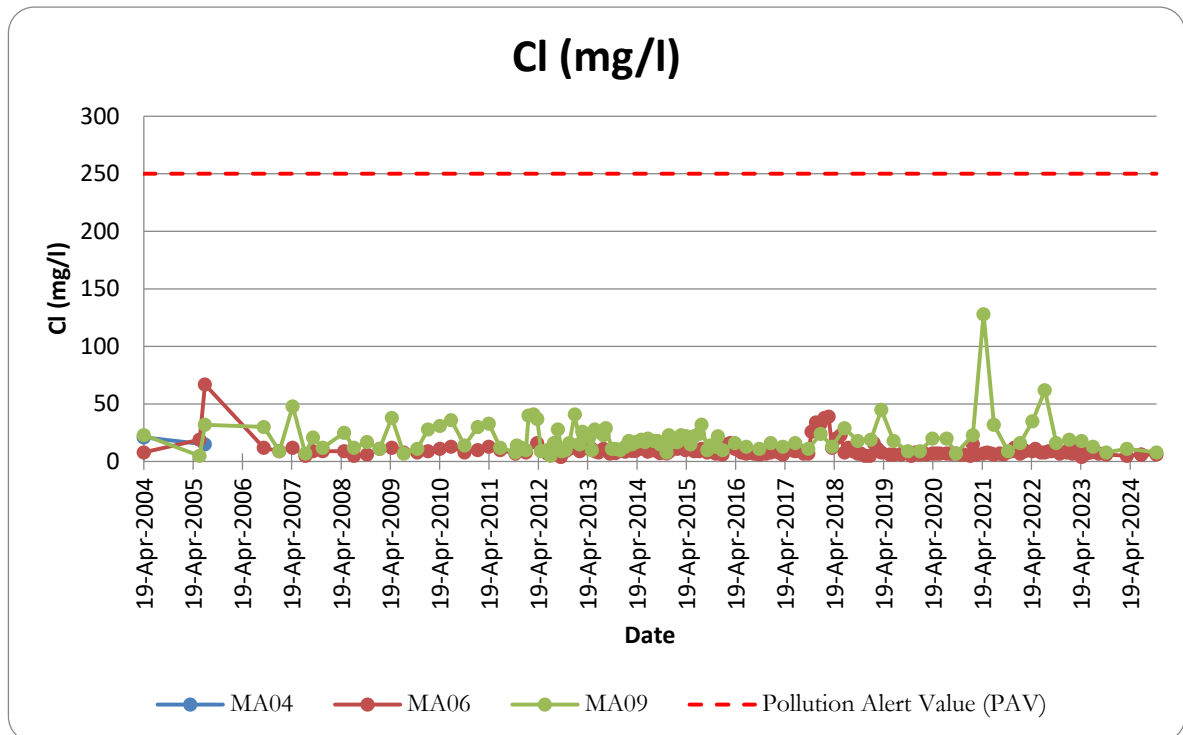


Figure 6: Cl Concentration timeseries within the Culvert

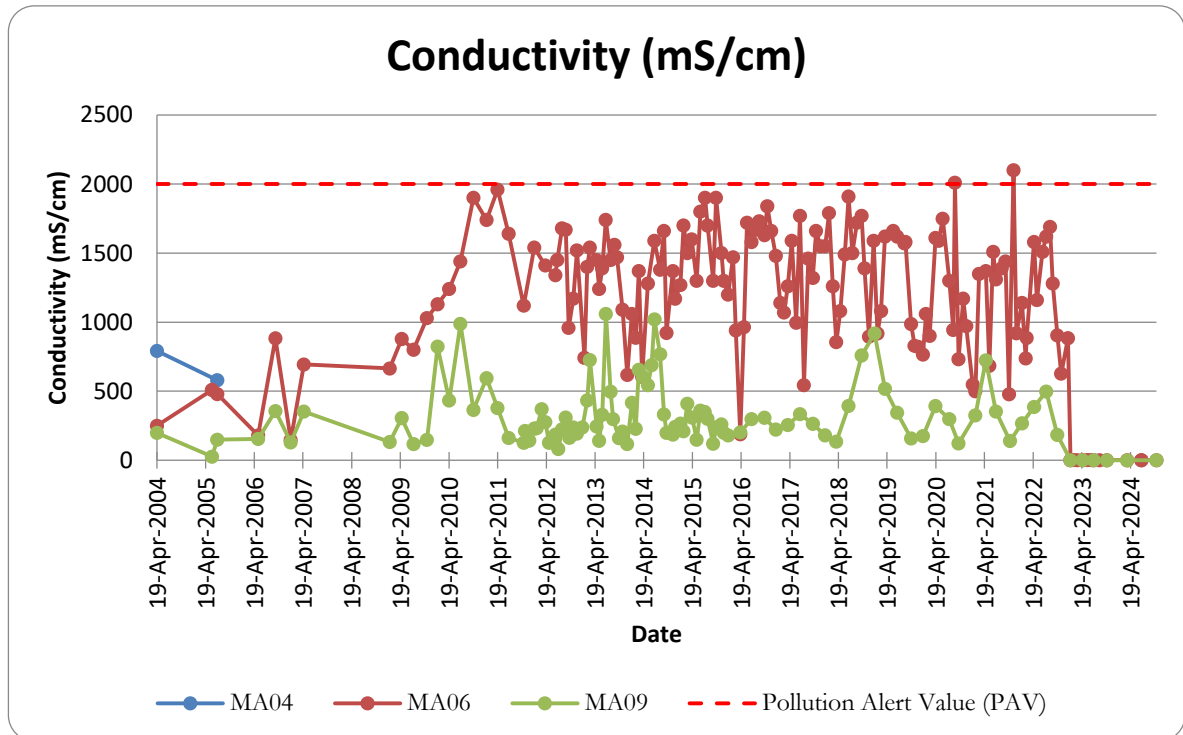


Figure 7: Electrical Conductivity timeseries within the Culvert

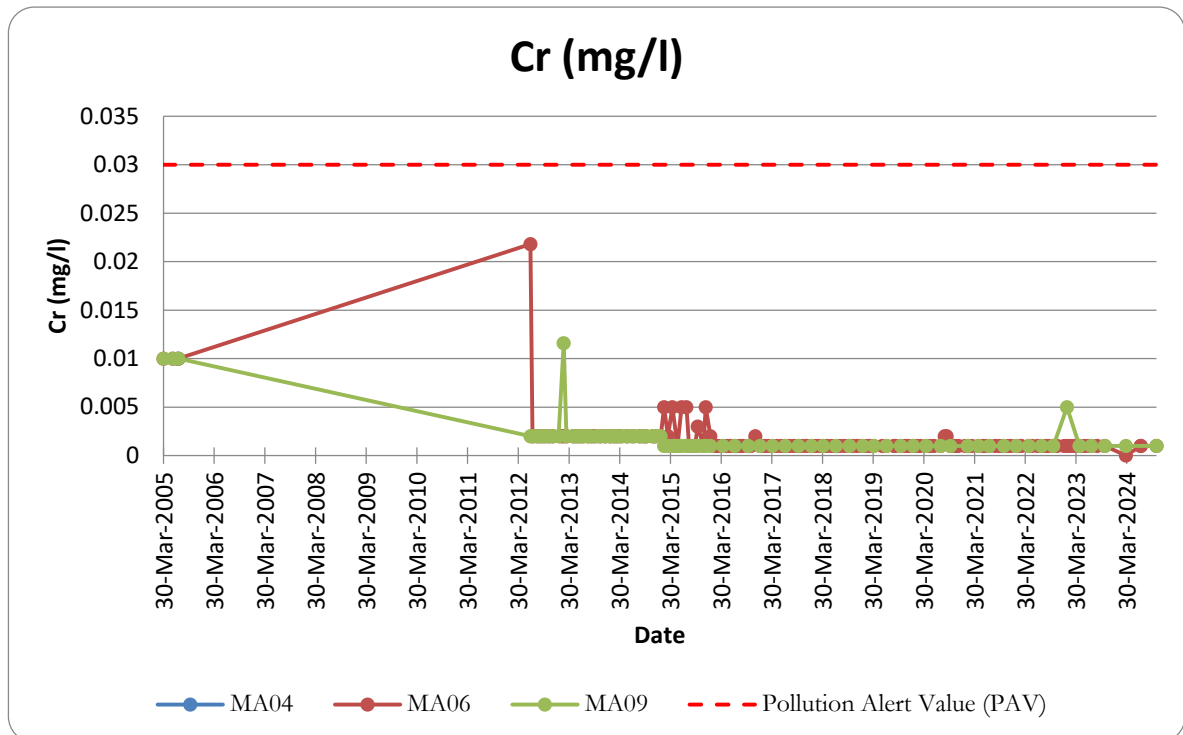


Figure 8: Cr Concentration timeseries within the Culvert

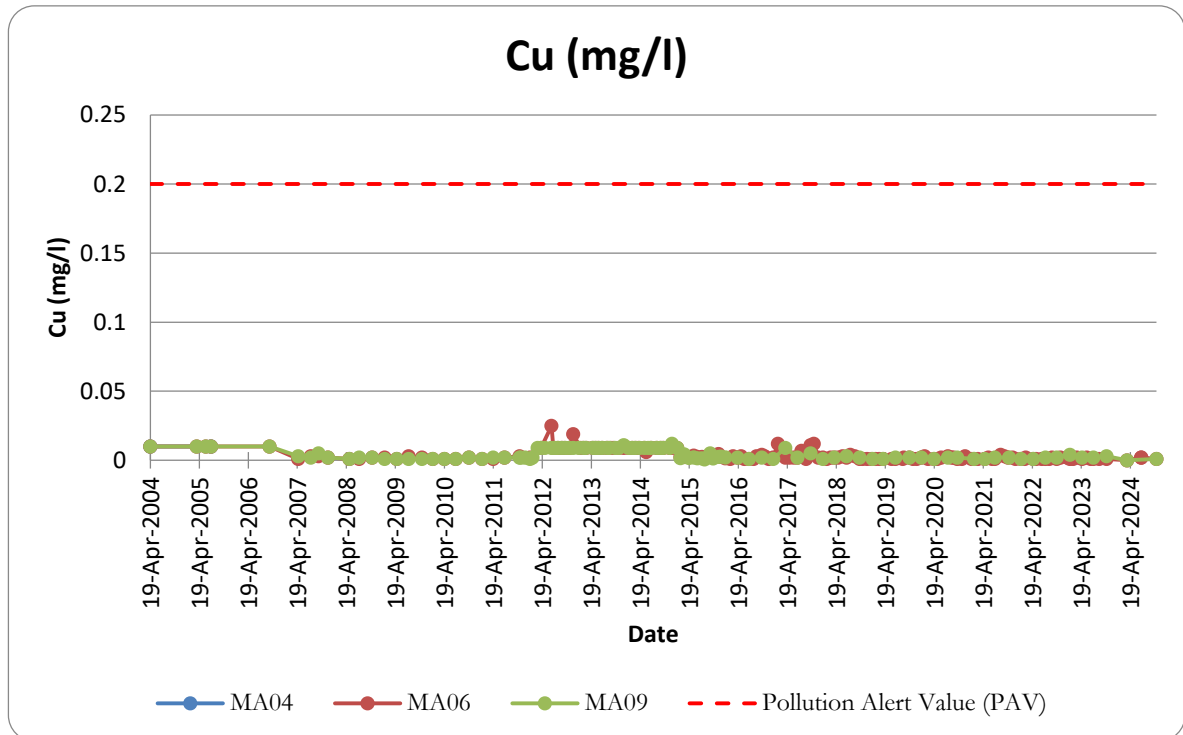


Figure 9: Cu Concentration timeseries within the Culvert

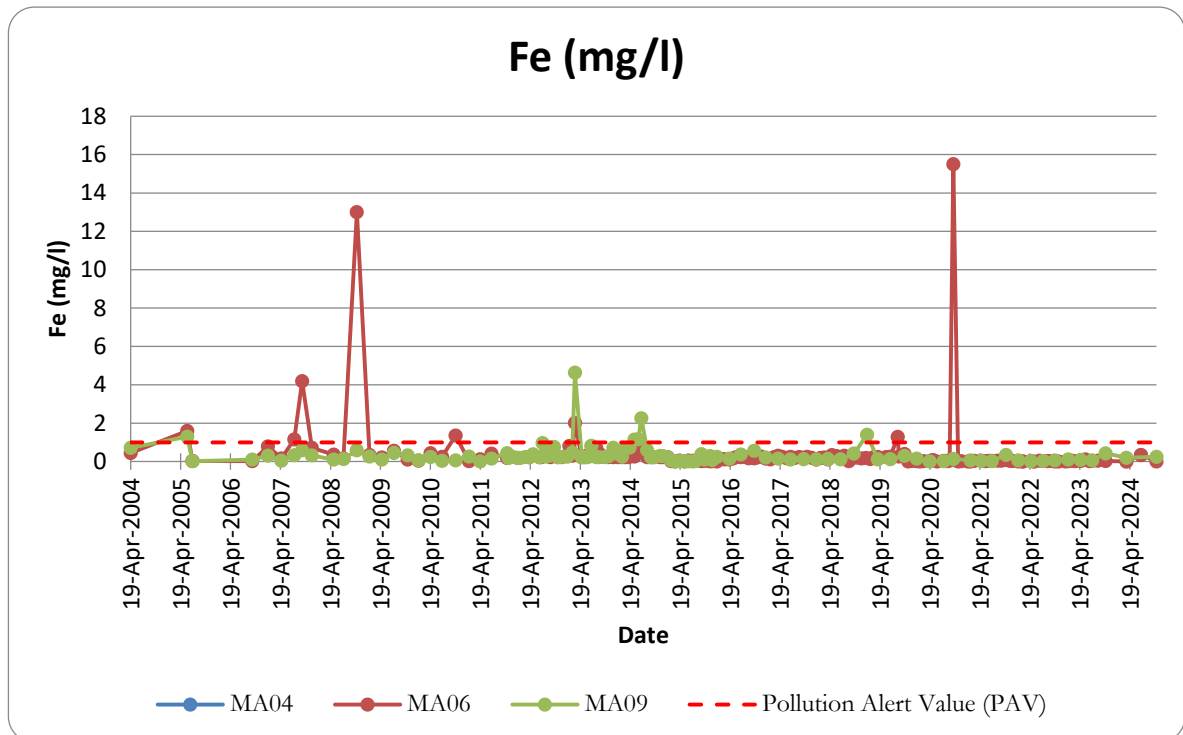


Figure 10: Fe Concentration timeseries within the Culvert

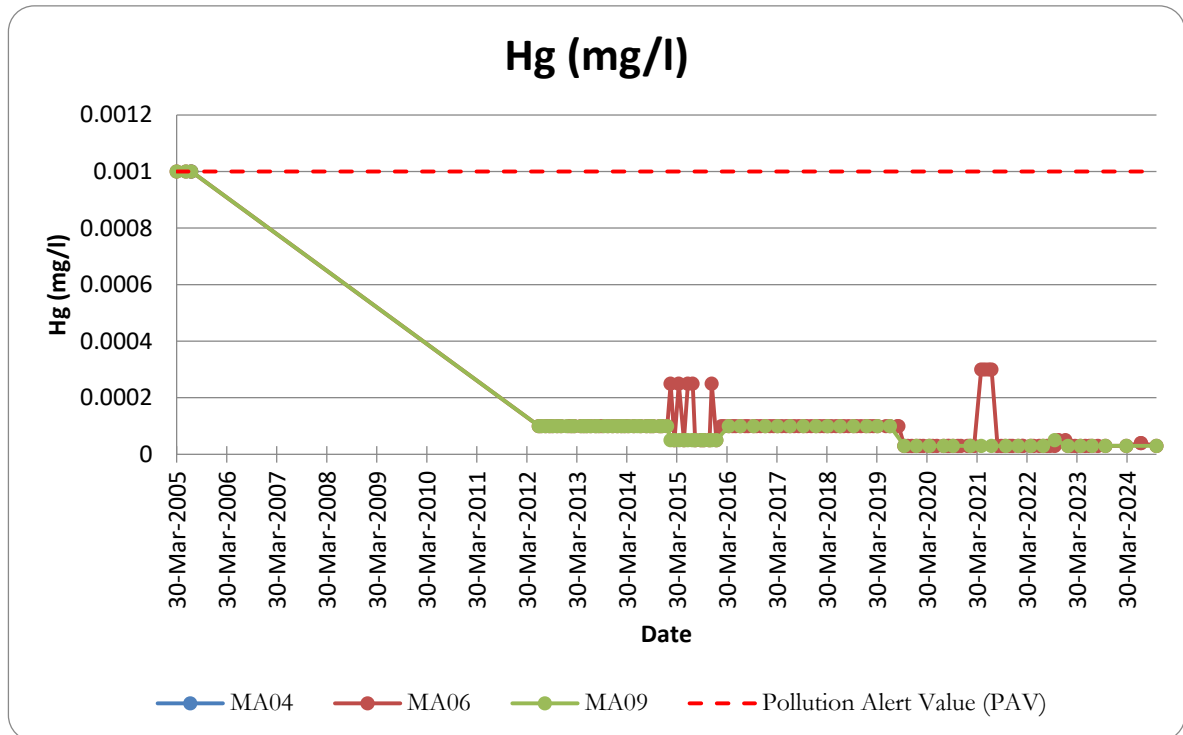


Figure 11: Hg Concentration timeseries within the Culvert

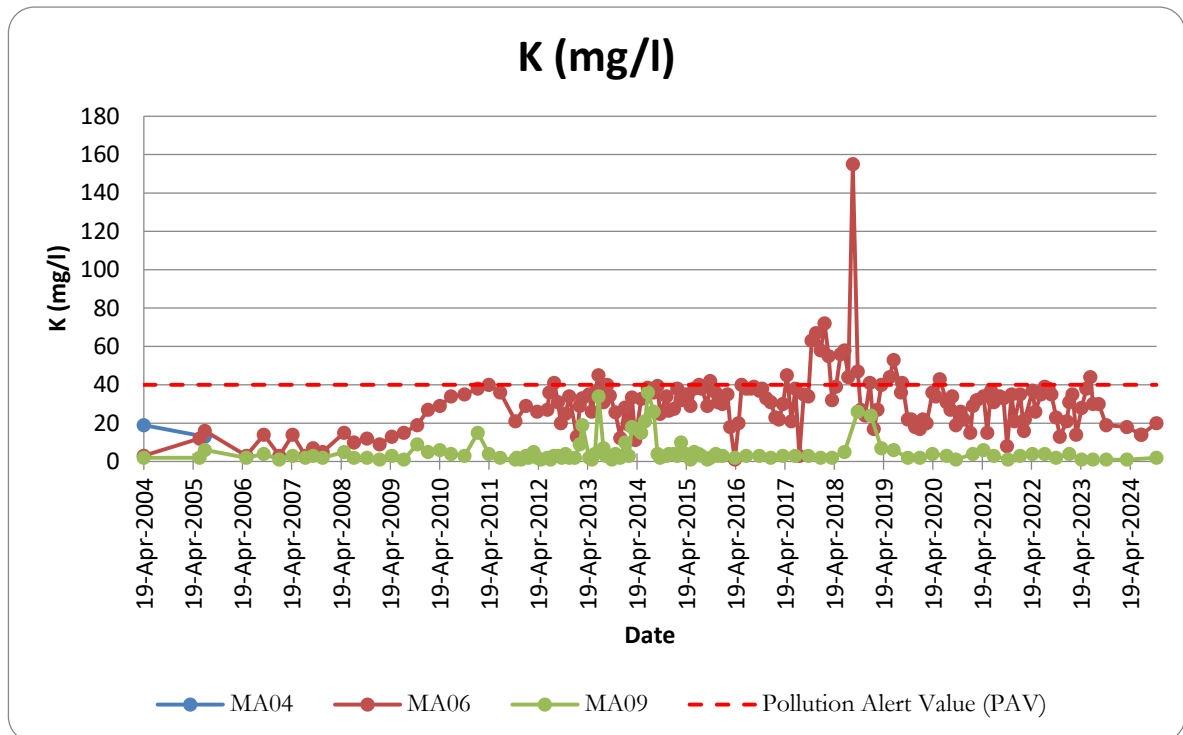


Figure 12: K Concentration timeseries within the Culvert

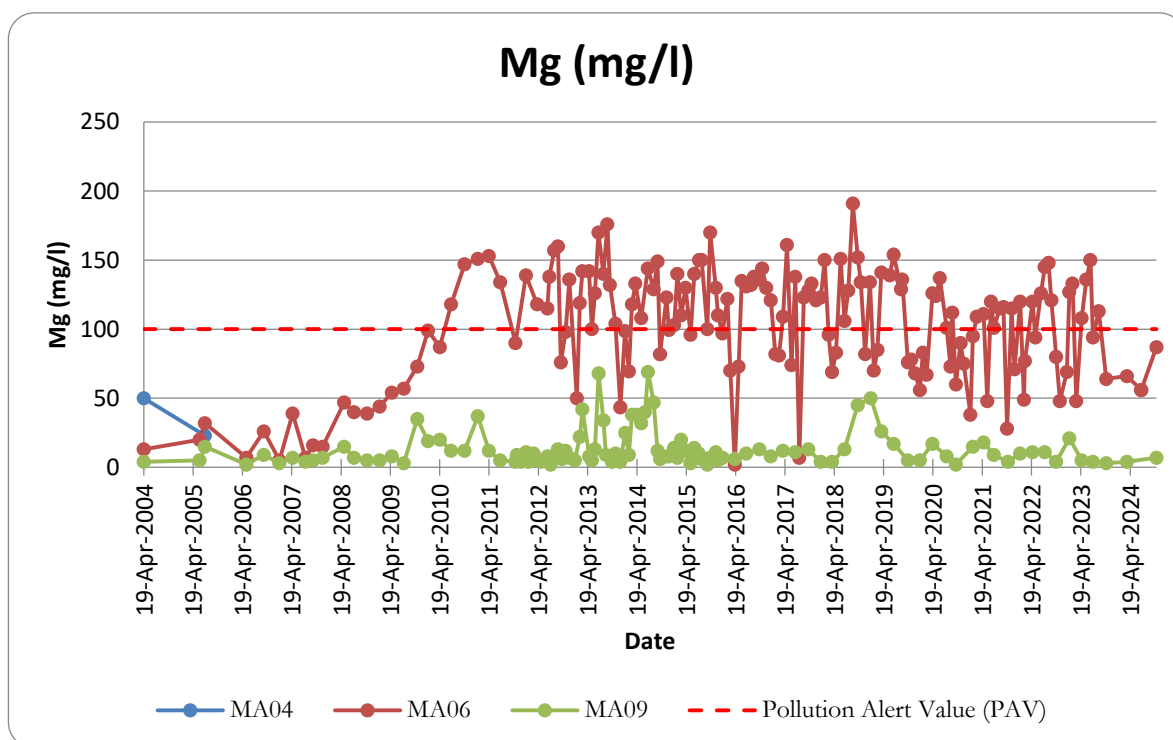


Figure 13: Mg Concentration timeseries within the Culvert

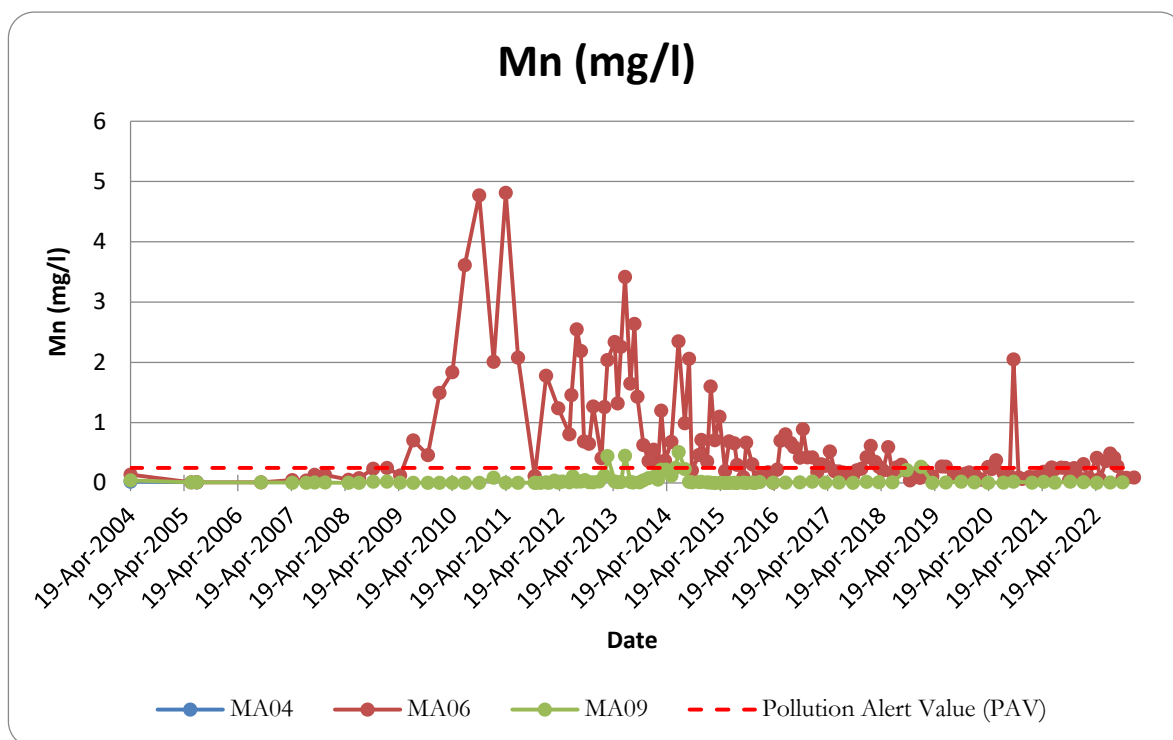


Figure 14: Mn Concentration timeseries within the Culvert

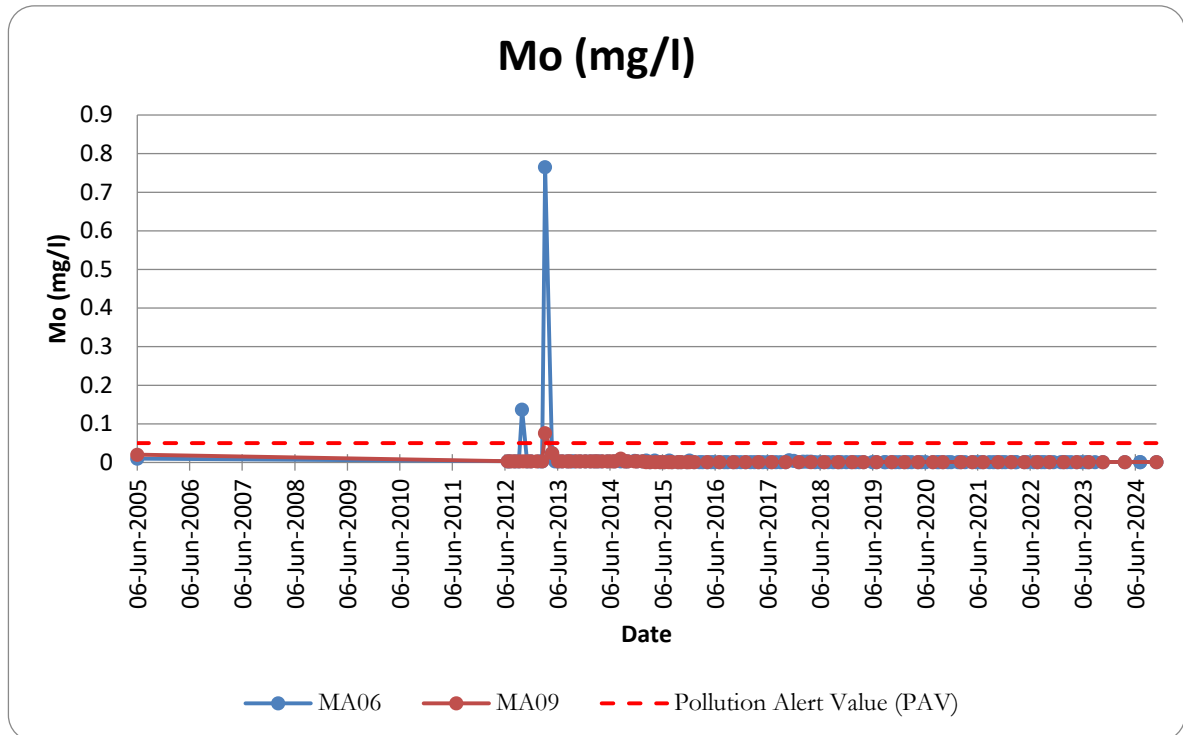


Figure 15: Mo Concentration timeseries within the Culvert

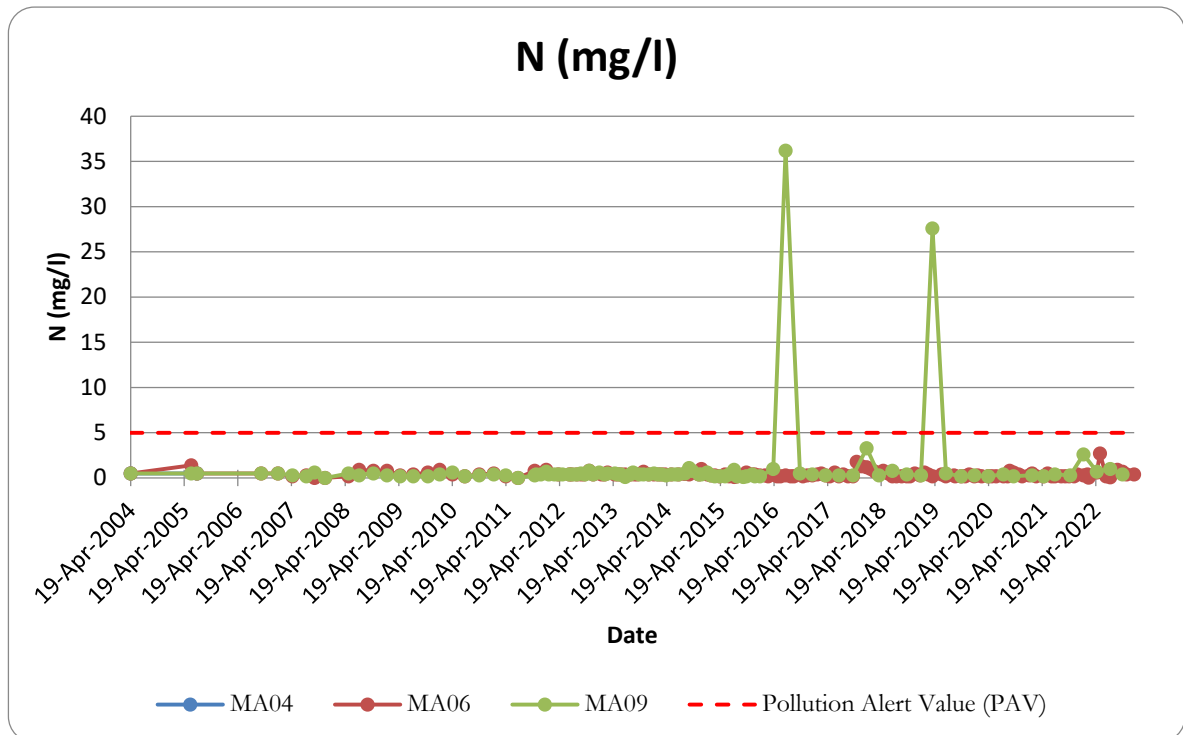


Figure 16: NI Concentration timeseries within the Culvert

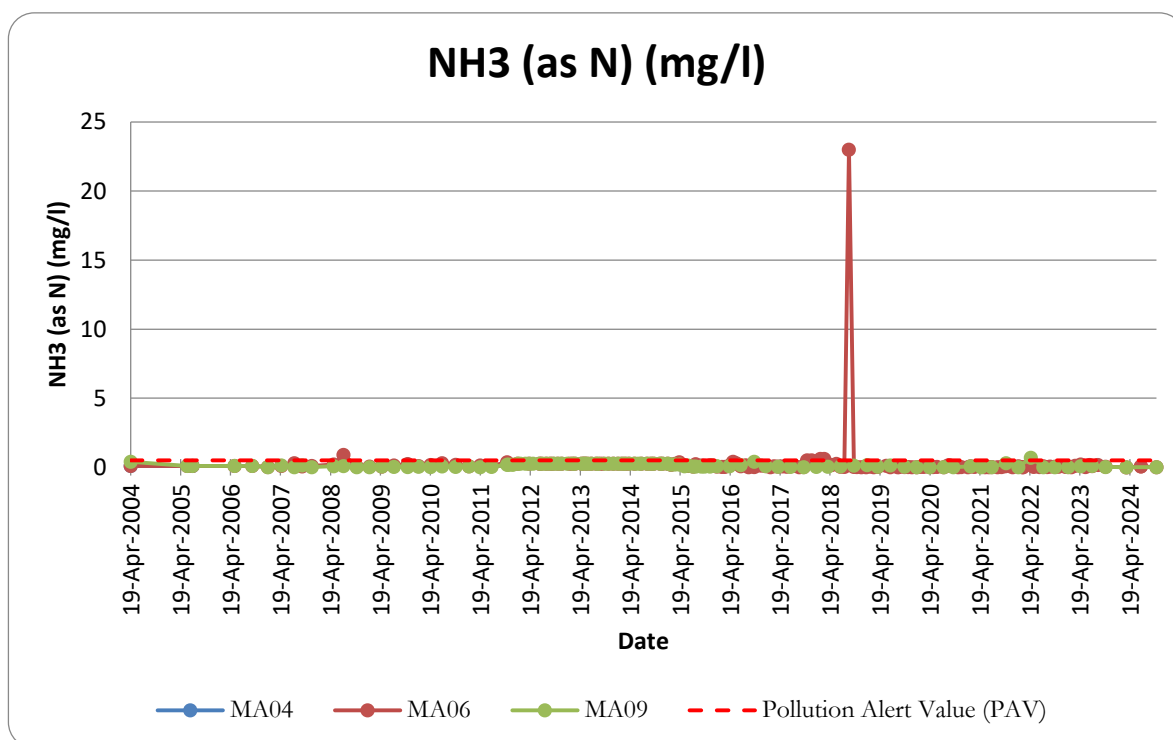


Figure 17: NH3 (as N) Concentration timeseries within the Culvert

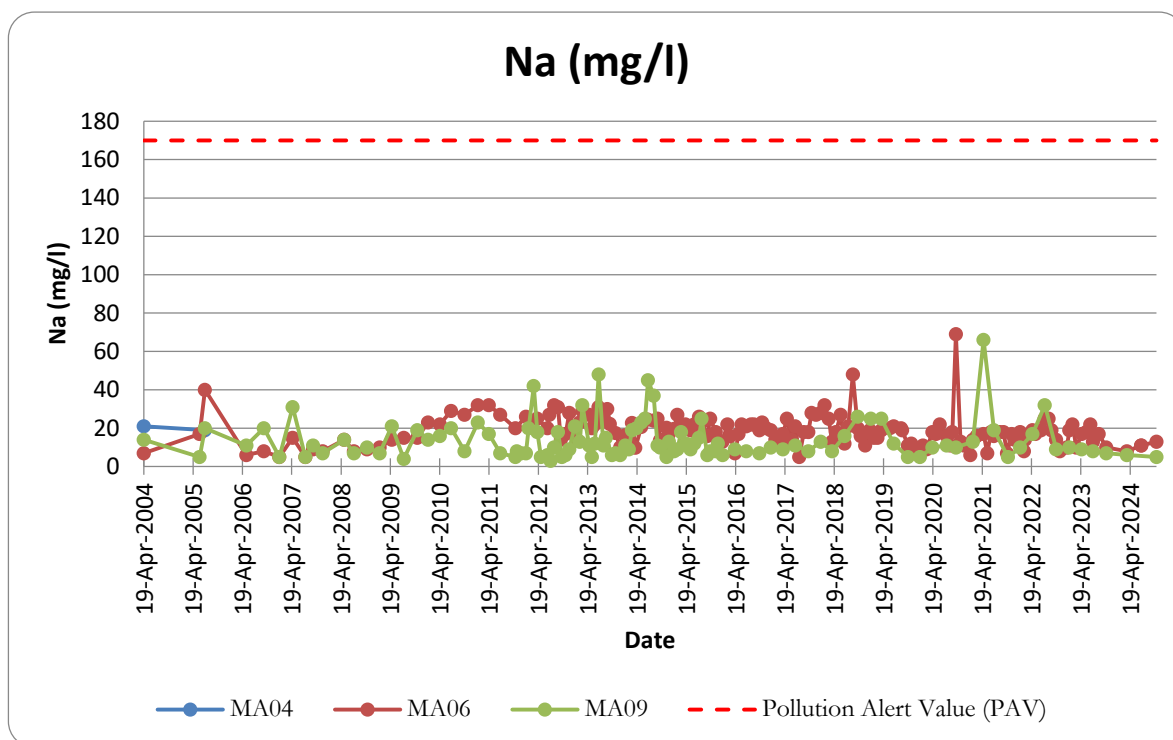


Figure 18: Na Concentration timeseries within the Culvert

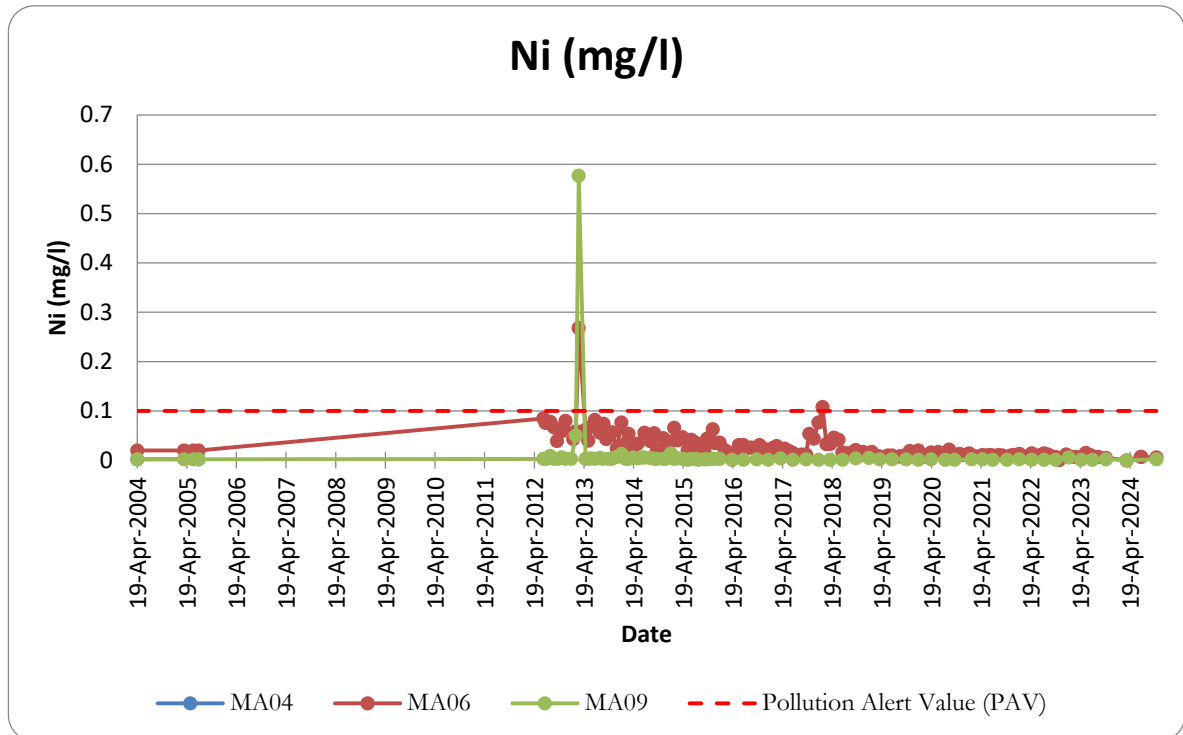


Figure 19: Ni Concentration timeseries within the Culvert

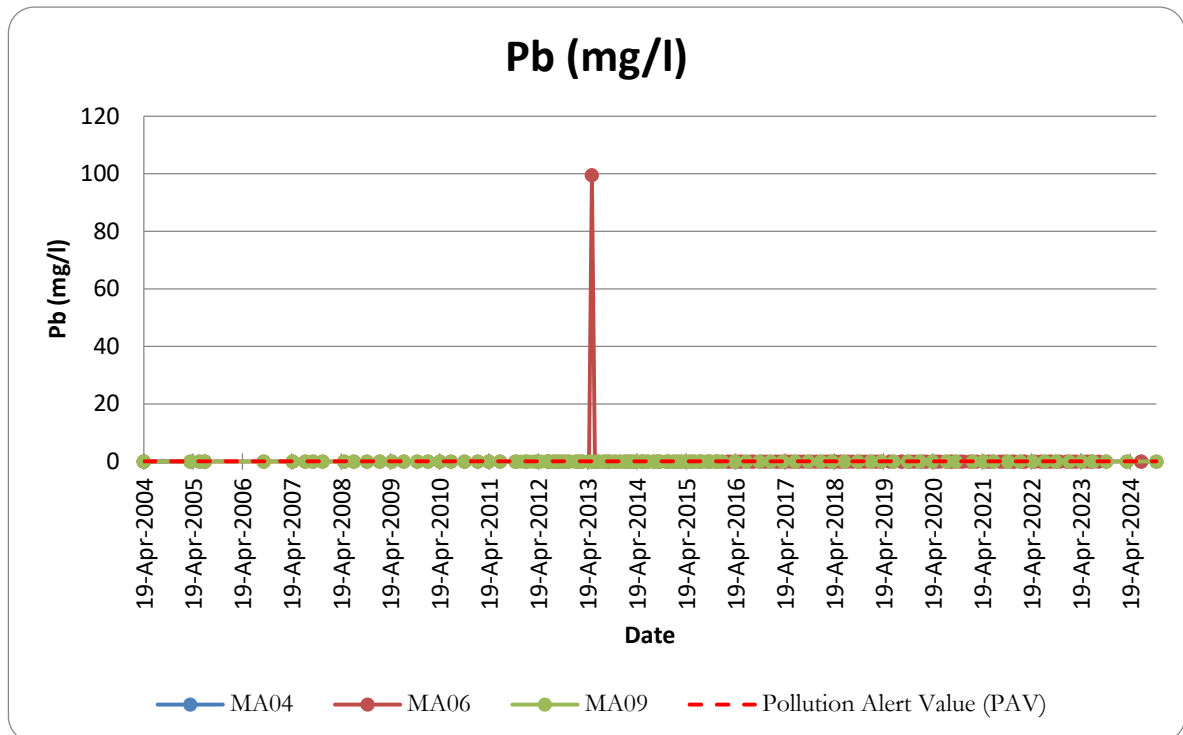


Figure 20: Pb Concentration timeseries within the Culvert

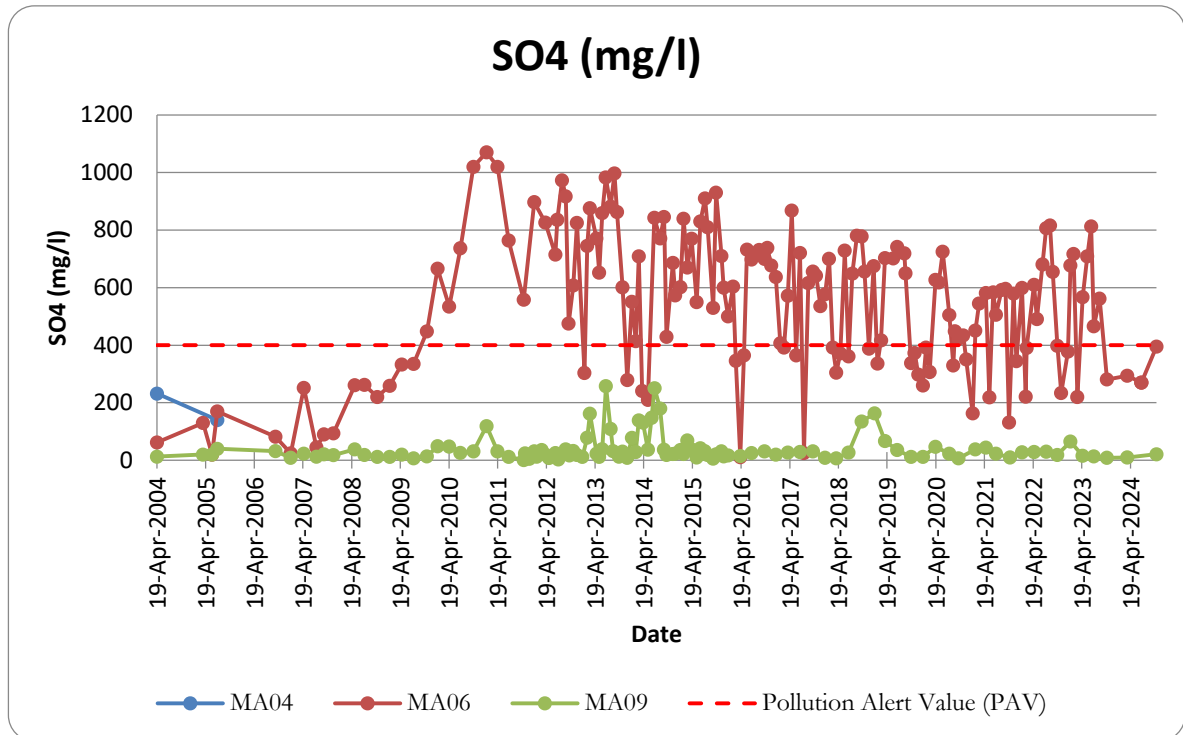
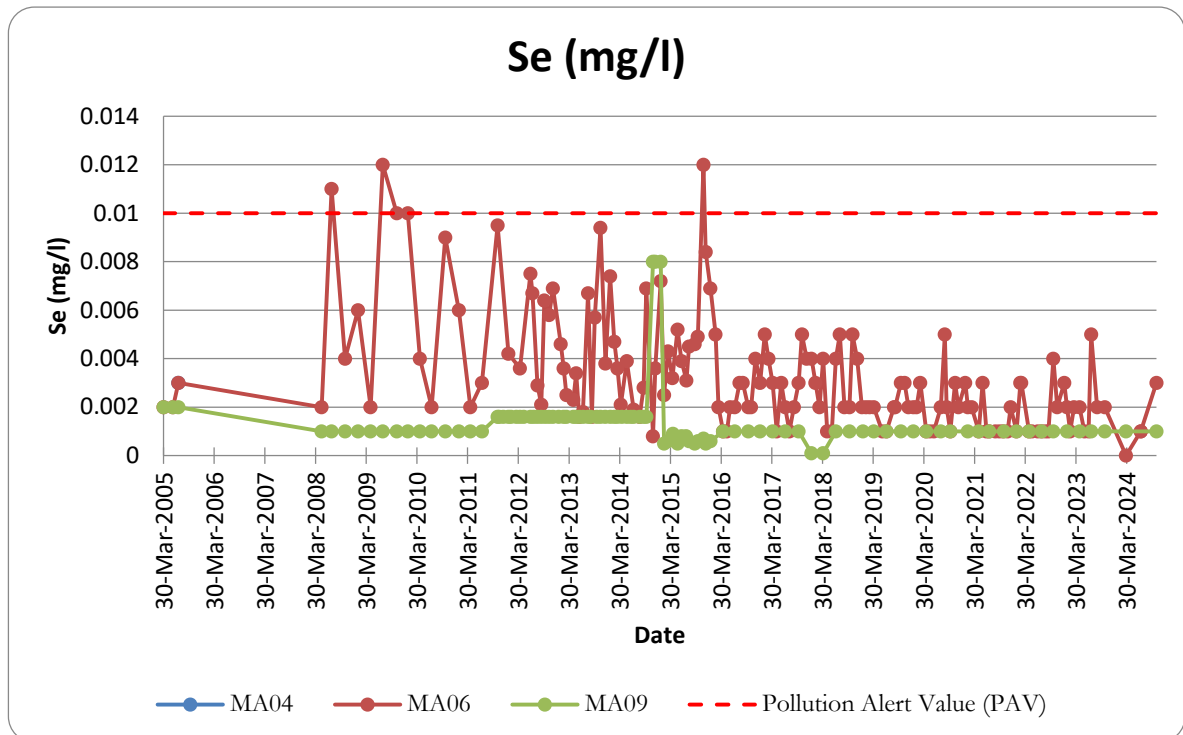
Figure 21: SO<sub>4</sub> Concentration timeseries within the Culvert

Figure 22: Se Concentration timeseries within the Culvert

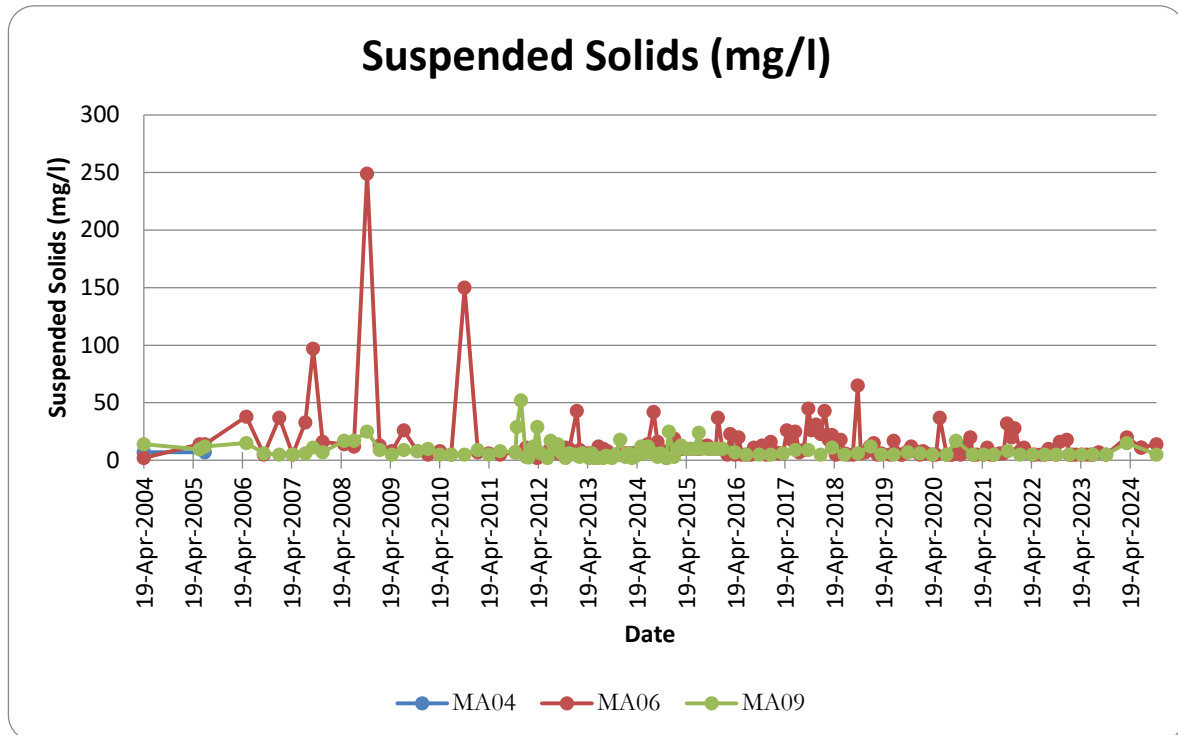


Figure 23: Suspended Solids Concentration timeseries within the Culvert

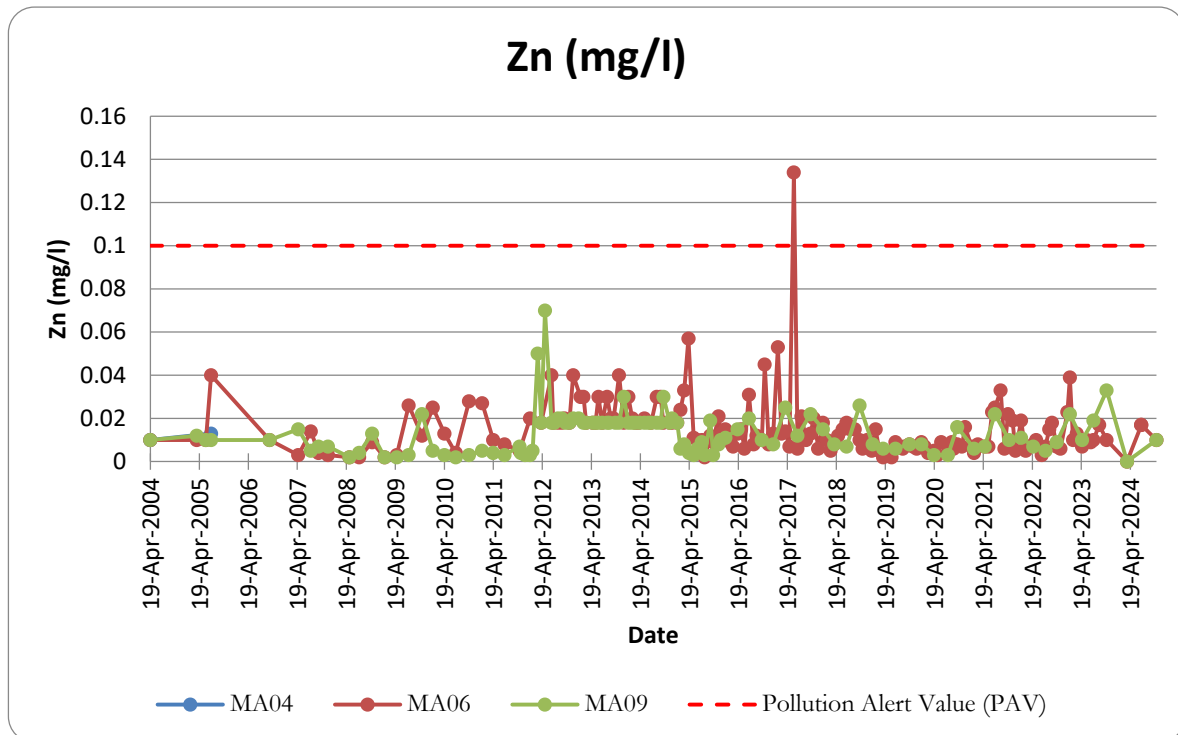


Figure 24: Zn Concentration timeseries within the Culvert

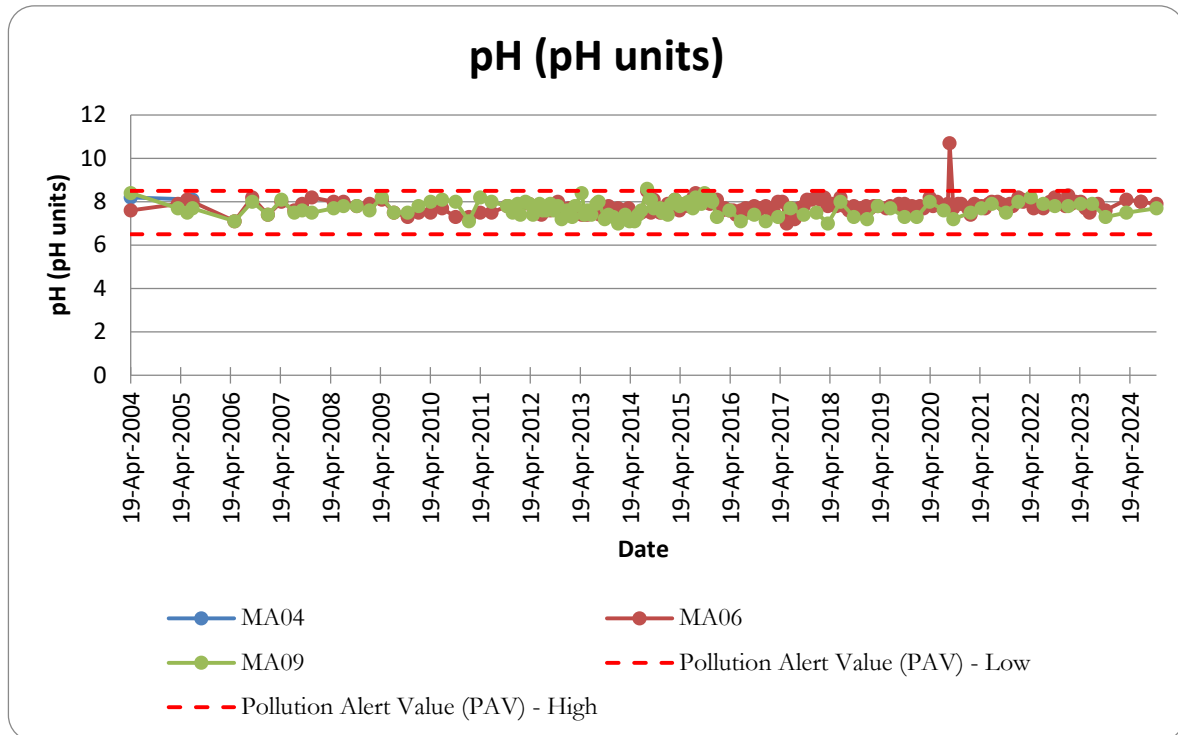


Figure 25: pH Concentration timeseries within the Culvert

### 3 CULVERT - INLET

Table 3 Culvert Inlet Monitoring Point Statistics

| Parameter    | Units | Stat  | MA01     | MA02     |
|--------------|-------|-------|----------|----------|
| Al           | mg/l  | min   | 0        | 0.005    |
|              |       | max   | 0.946    | 1.14     |
|              |       | mean  | 0.06876  | 0.07733  |
|              |       | count | 74       | 57       |
| Alkalinity   | mg/l  | min   | 32       | 51       |
|              |       | max   | 259      | 331      |
|              |       | mean  | 85.31    | 168.673  |
|              |       | count | 67       | 49       |
| As           | mg/l  | min   | 0.0005   | 0.001    |
|              |       | max   | 0.01     | 0.01     |
|              |       | mean  | 0.0016   | 0.002    |
|              |       | count | 51       | 34       |
| Ca           | mg/l  | min   | 14       | 25       |
|              |       | max   | 117      | 159      |
|              |       | mean  | 37.007   | 79.069   |
|              |       | count | 76       | 59       |
| Cd           | mg/l  | min   | 0        | 0.00002  |
|              |       | max   | 0.002    | 0.004    |
|              |       | mean  | 0.00036  | 0.00054  |
|              |       | count | 52       | 35       |
| Cl           | mg/l  | min   | 8        | 7        |
|              |       | max   | 39       | 96       |
|              |       | mean  | 14.338   | 36.771   |
|              |       | count | 75       | 56       |
| Conductivity | mS/cm | min   | 0.145    | 79       |
|              |       | max   | 1300     | 1590     |
|              |       | mean  | 239.0684 | 607.3396 |
|              |       | count | 70       | 53       |
| Cr           | mg/l  | min   | 0.001    | 0.001    |
|              |       | max   | 0.01     | 0.0367   |
|              |       | mean  | 0.001745 | 0.003197 |
|              |       | count | 51       | 34       |
| Cu           | mg/l  | min   | 0        | 0.001    |
|              |       | max   | 0.01     | 0.039    |
|              |       | mean  | 0.00378  | 0.00444  |
|              |       | count | 75       | 58       |
| Fe           | mg/l  | min   | 0.01     | 0.01     |
|              |       | max   | 1.33     | 1.15     |
|              |       | mean  | 0.2117   | 0.2561   |
|              |       | count | 75       | 58       |
| Hg           | mg/l  | min   | 0.00003  | 0.00003  |
|              |       | max   | 0.001    | 0.001    |
|              |       | mean  | 0.00012  | 0.00017  |
|              |       | count | 51       | 34       |
| K            | mg/l  | min   | 1        | 2        |
|              |       | max   | 27       | 62       |
|              |       | mean  | 2.23     | 11.347   |
|              |       | count | 76       | 59       |
| Mg           | mg/l  | min   | 1        | 2        |
|              |       | max   | 94       | 104      |
|              |       | mean  | 4.272    | 20.554   |
|              |       | count | 75       | 59       |



| Parameter        | Units    | Stat  | MA01     | MA02    |
|------------------|----------|-------|----------|---------|
| Mn               | mg/l     | min   | 0.001    | 0.001   |
|                  |          | max   | 0.381    | 0.686   |
|                  |          | mean  | 0.0191   | 0.08067 |
|                  |          | count | 68       | 57      |
| Mo               | mg/l     | min   | 0.001    | 0.001   |
|                  |          | max   | 0.11     | 0.115   |
|                  |          | mean  | 0.00429  | 0.0065  |
|                  |          | count | 49       | 32      |
| N                | mg/l     | min   | 0        | 0       |
|                  |          | max   | 3.4      | 17.3    |
|                  |          | mean  | 0.9207   | 1.2248  |
|                  |          | count | 68       | 56      |
| NH3 (as N)       | mg/l     | min   | 0        | 0.01    |
|                  |          | max   | 0.9      | 9       |
|                  |          | mean  | 0.127    | 0.406   |
|                  |          | count | 76       | 59      |
| Na               | mg/l     | min   | 2        | 6       |
|                  |          | max   | 32       | 51      |
|                  |          | mean  | 9.283    | 21.806  |
|                  |          | count | 76       | 59      |
| Ni               | mg/l     | min   | 0.001    | 0.001   |
|                  |          | max   | 0.023    | 0.137   |
|                  |          | mean  | 0.00348  | 0.01774 |
|                  |          | count | 52       | 35      |
| Pb               | mg/l     | min   | 0.0002   | 0.0003  |
|                  |          | max   | 0.006    | 0.04    |
|                  |          | mean  | 0.00221  | 0.00314 |
|                  |          | count | 75       | 58      |
| SO4              | mg/l     | min   | 2.7      | 19      |
|                  |          | max   | 500      | 386     |
|                  |          | mean  | 21.879   | 101.786 |
|                  |          | count | 76       | 57      |
| Se               | mg/l     | min   | 0.0001   | 0.0001  |
|                  |          | max   | 0.0057   | 0.004   |
|                  |          | mean  | 0.001314 | 0.00201 |
|                  |          | count | 64       | 51      |
| Suspended Solids | mg/l     | min   | 1        | 2       |
|                  |          | max   | 166      | 75      |
|                  |          | mean  | 14.947   | 18.288  |
|                  |          | count | 76       | 59      |
| Zn               | mg/l     | min   | 0        | 0.002   |
|                  |          | max   | 0.036    | 0.07    |
|                  |          | mean  | 0.01081  | 0.01438 |
|                  |          | count | 74       | 58      |
| pH               | pH units | min   | 6.8      | 6.9     |
|                  |          | max   | 8.3      | 8.3     |
|                  |          | mean  | 7.681    | 7.707   |
|                  |          | count | 77       | 61      |

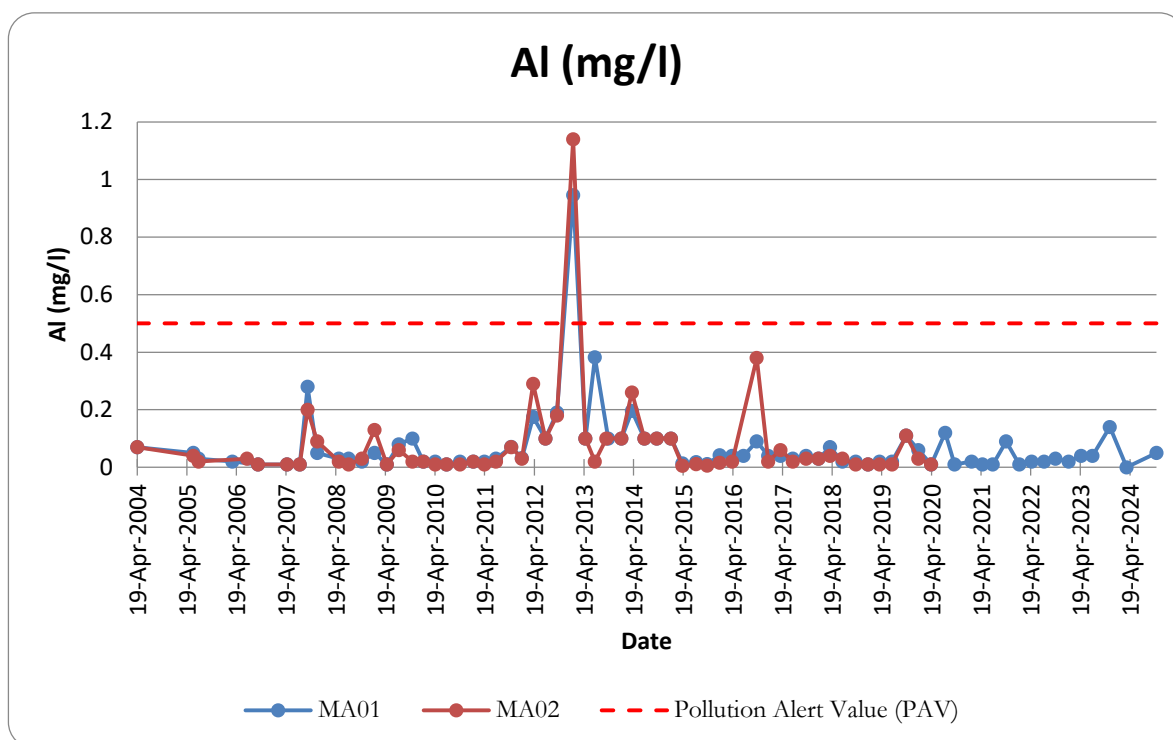


Figure 26: Al Concentration timeseries within the Culvert - Inlet

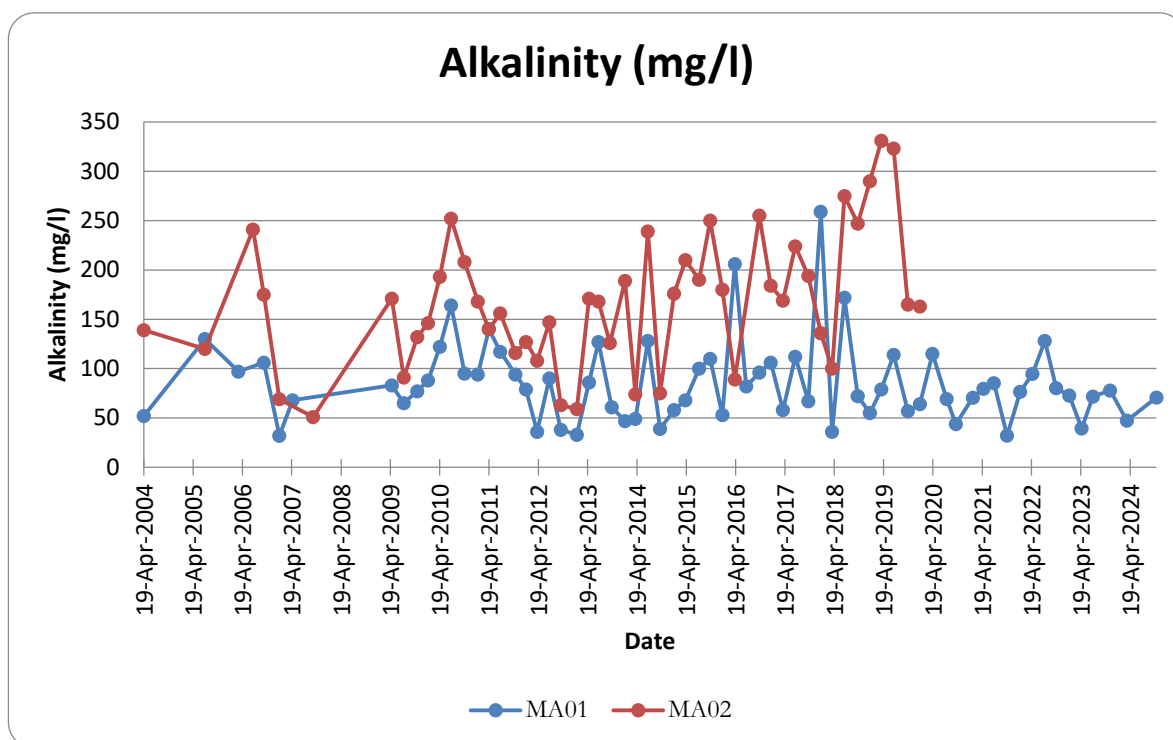


Figure 27: Alkalinity Concentration timeseries within the Culvert - Inlet

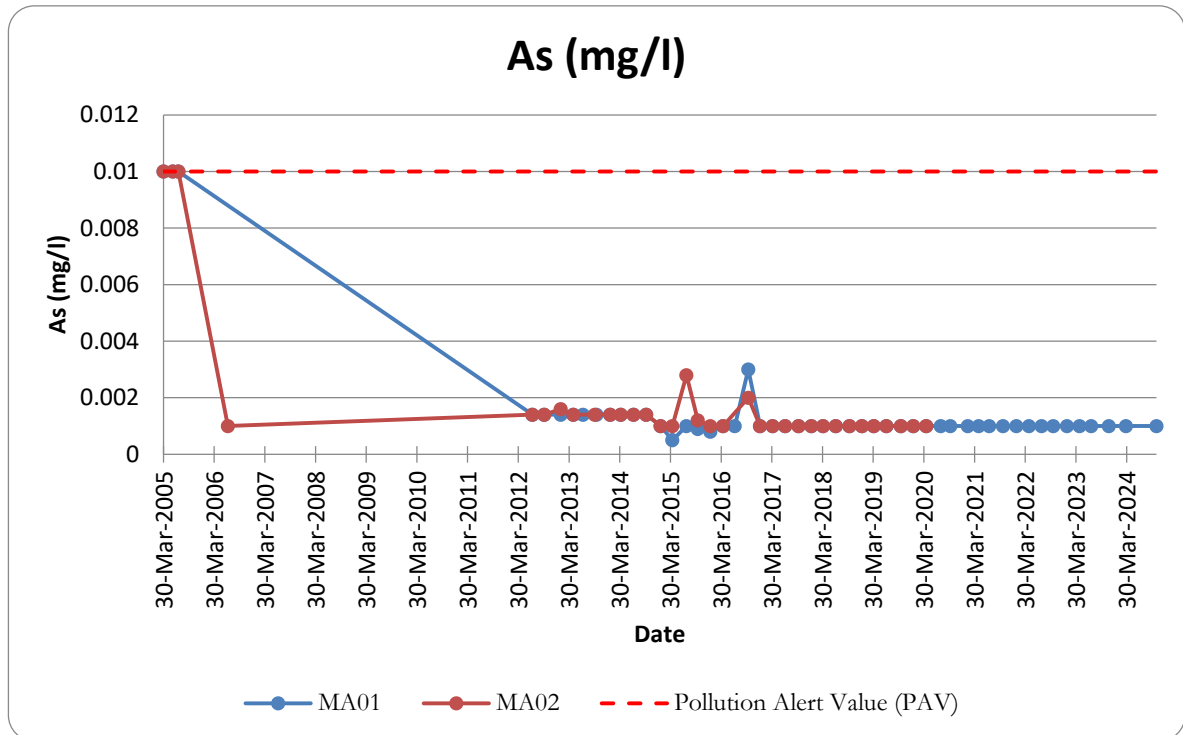


Figure 28: As Concentration timeseries within the Culvert - Inlet

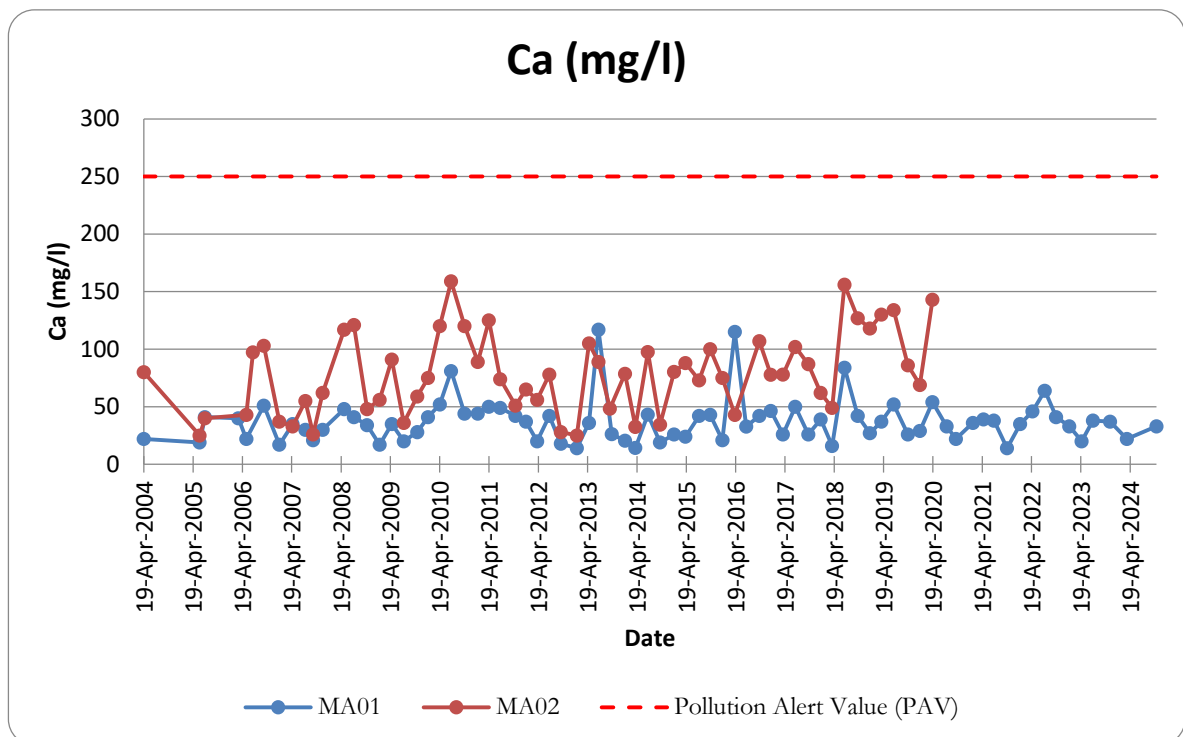


Figure 29: Ca Concentration timeseries within the Culvert - Inlet

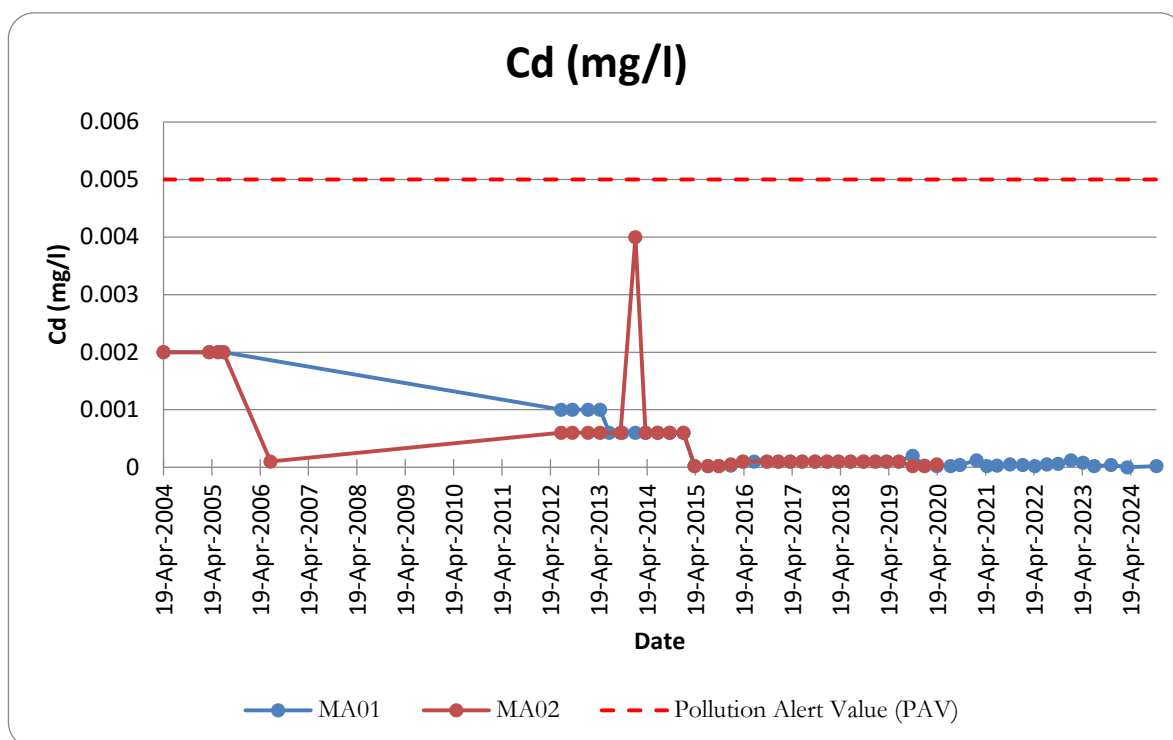


Figure 30: Cd Concentration timeseries within the Culvert - Inlet

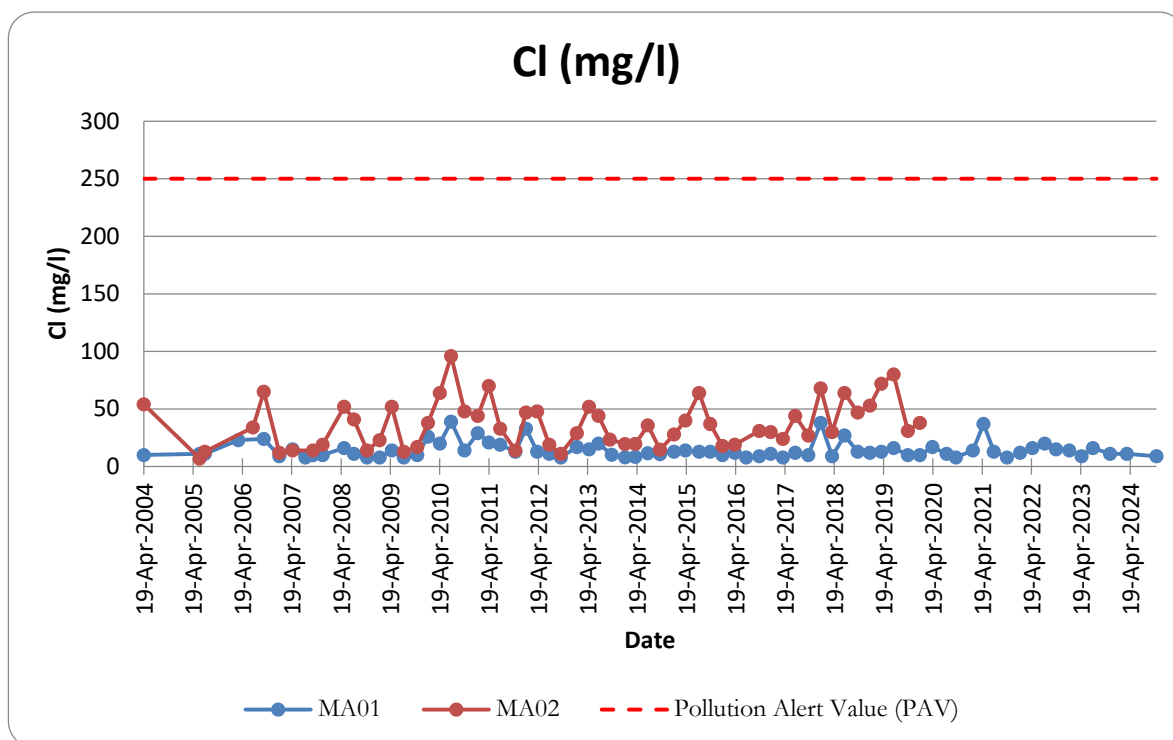


Figure 31: Cl Concentration timeseries within the Culvert - Inlet

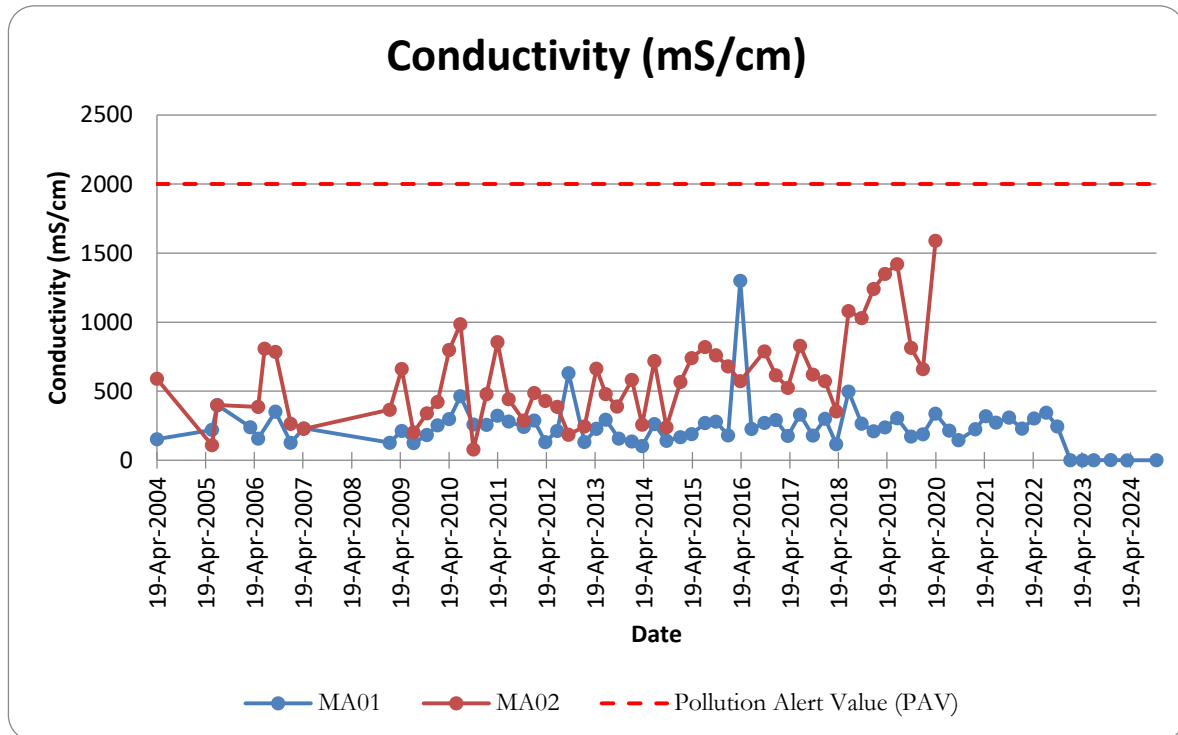


Figure 32: Electrical Conductivity timeseries within the Culvert - Inlet

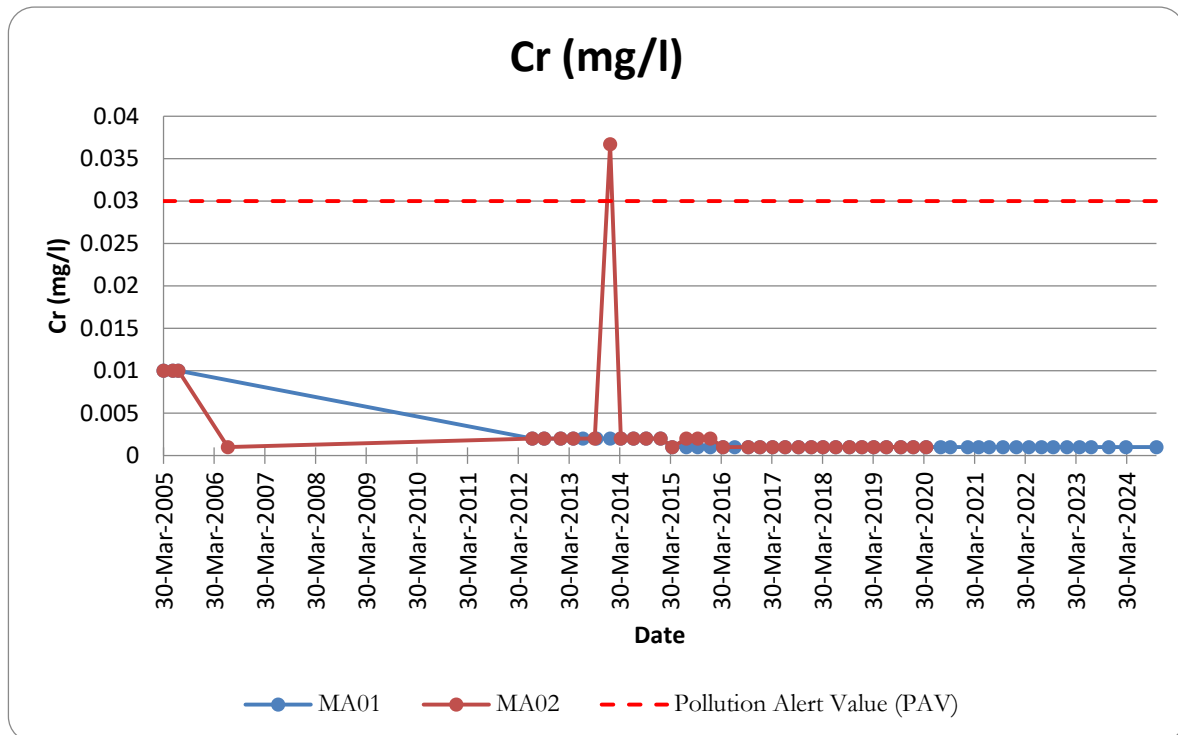


Figure 33:Cr Concentration timeseries within the Culvert - Inlet

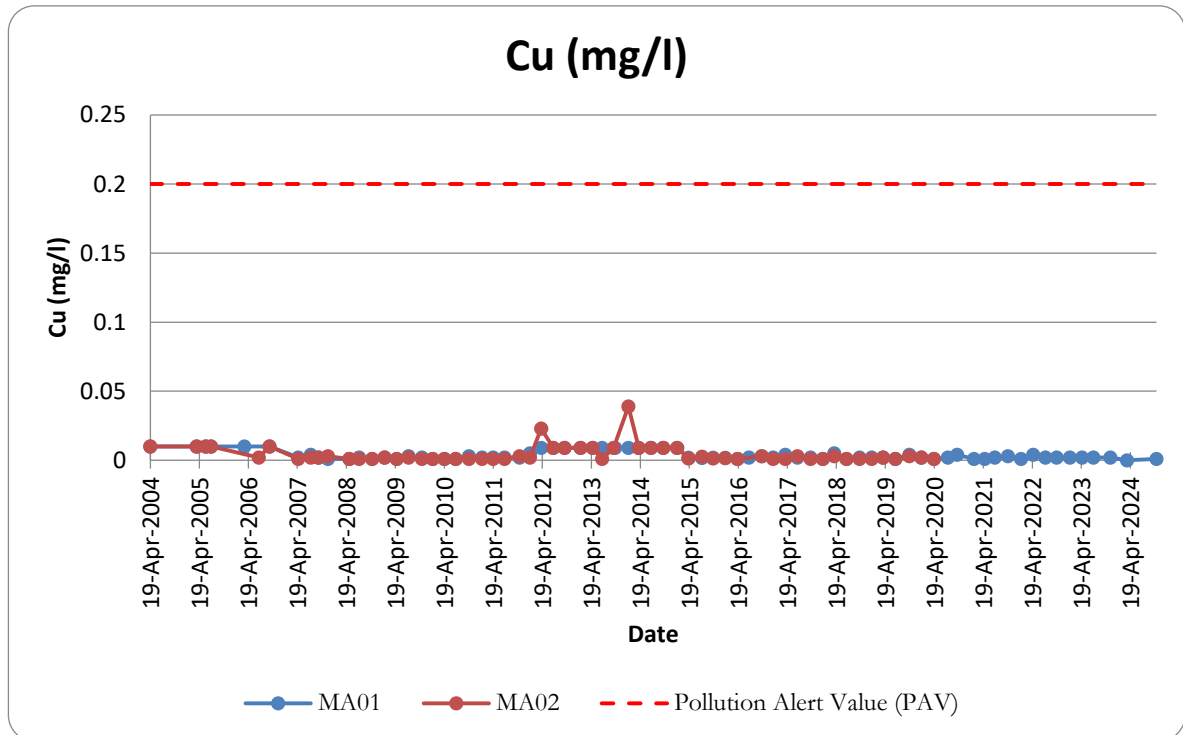


Figure 34: Cu Concentration timeseries within the Culvert - Inlet

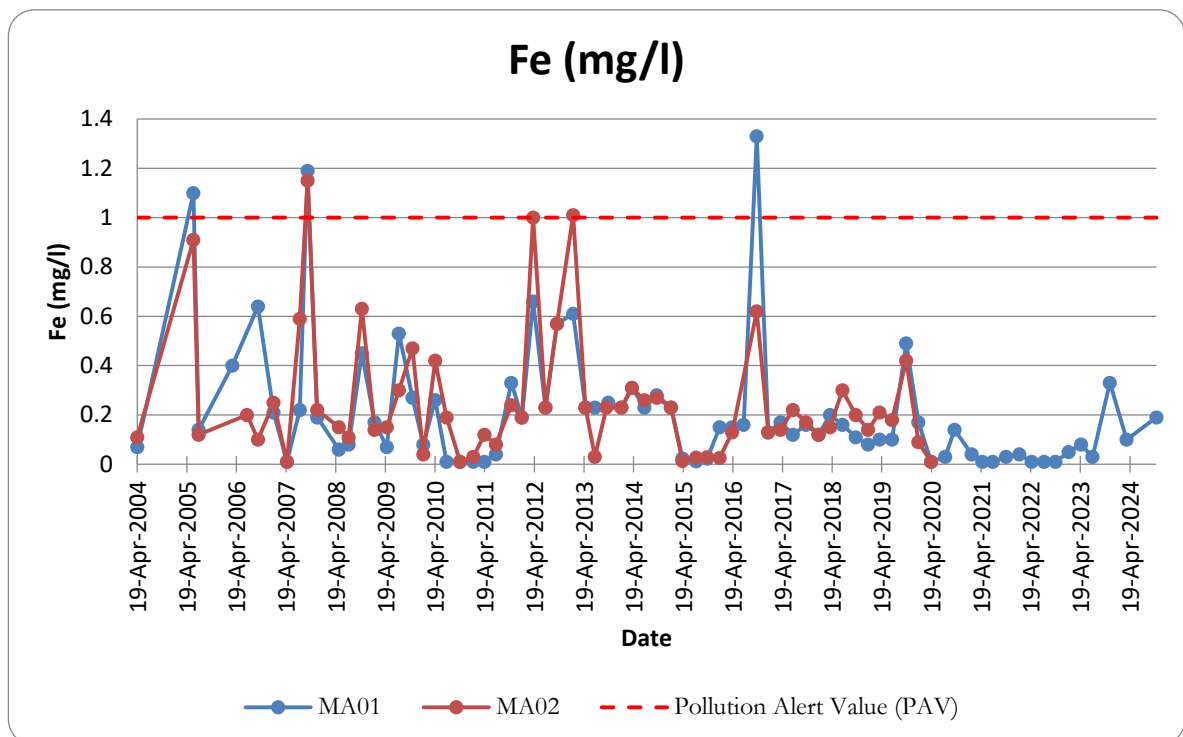


Figure 35: Fe Concentration timeseries within the Culvert - Inlet

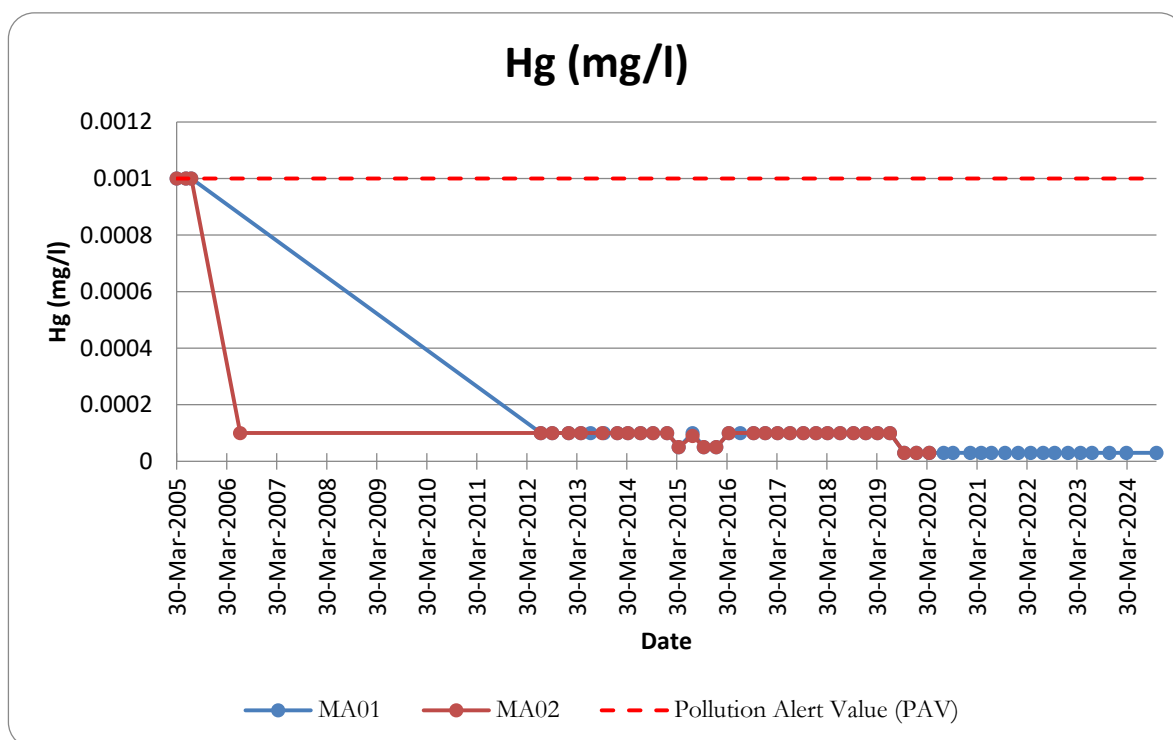


Figure 36: Hg Concentration timeseries within the Culvert - Inlet

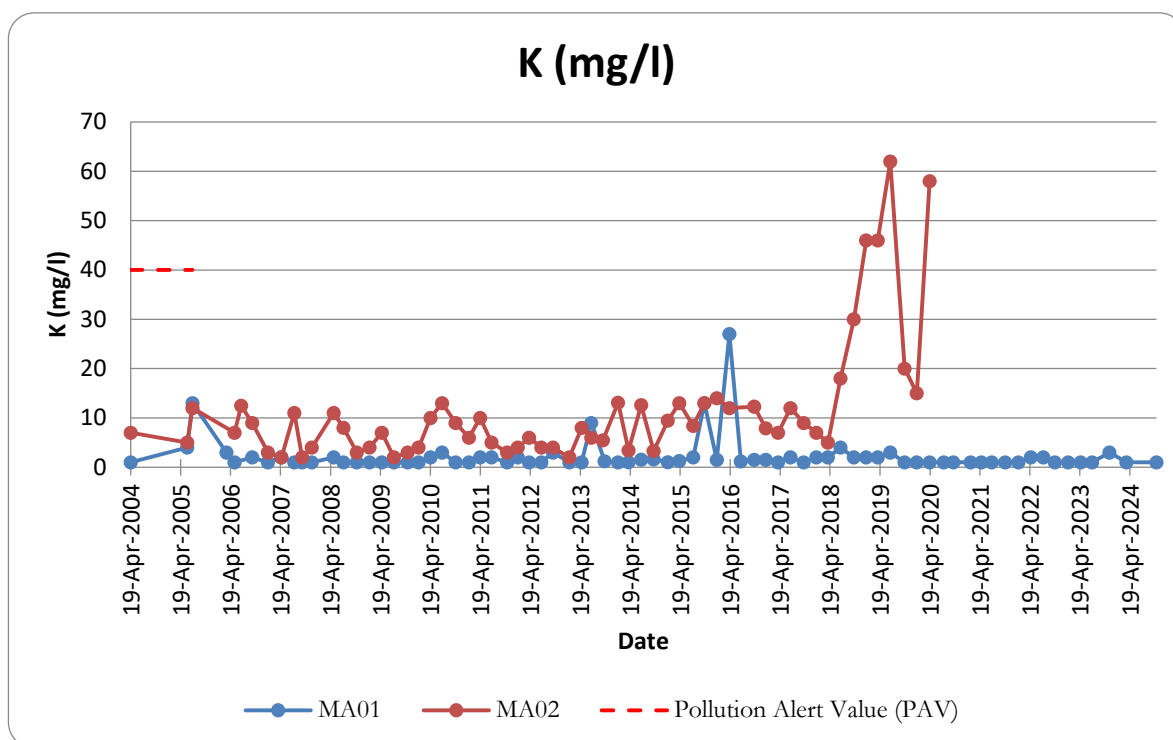


Figure 37: K Concentration timeseries within the Culvert - Inlet

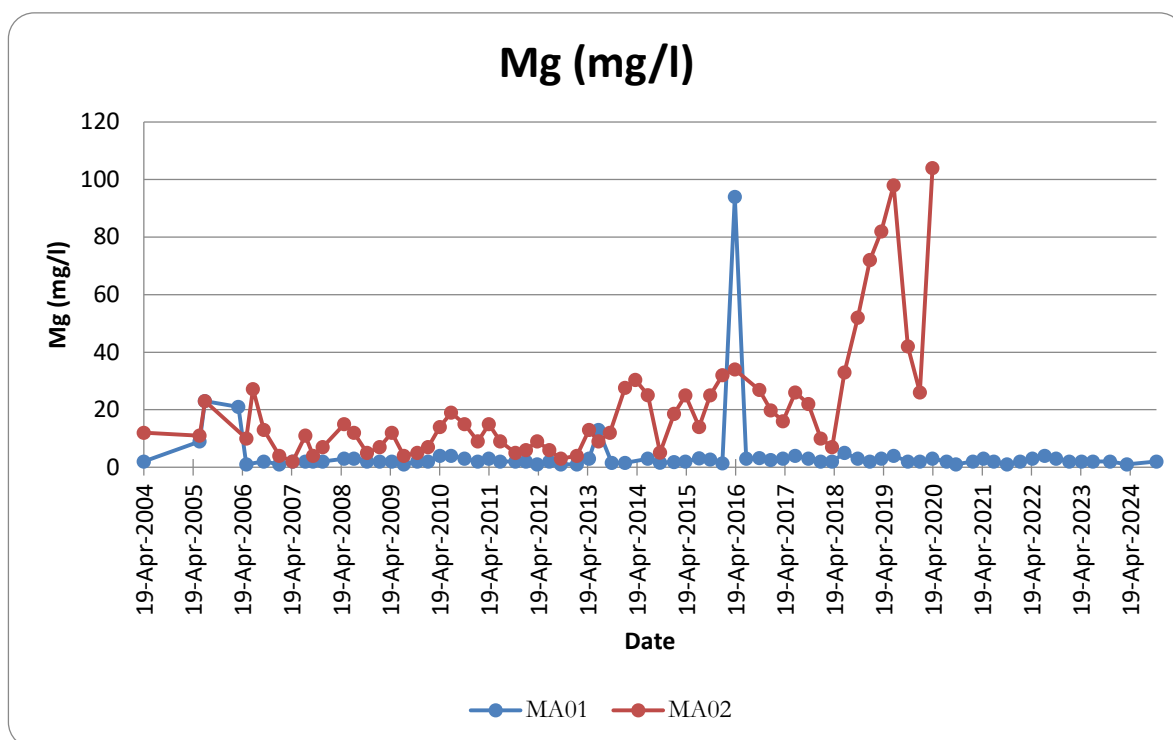


Figure 38: Mg Concentration timeseries within the Culvert - Inlet

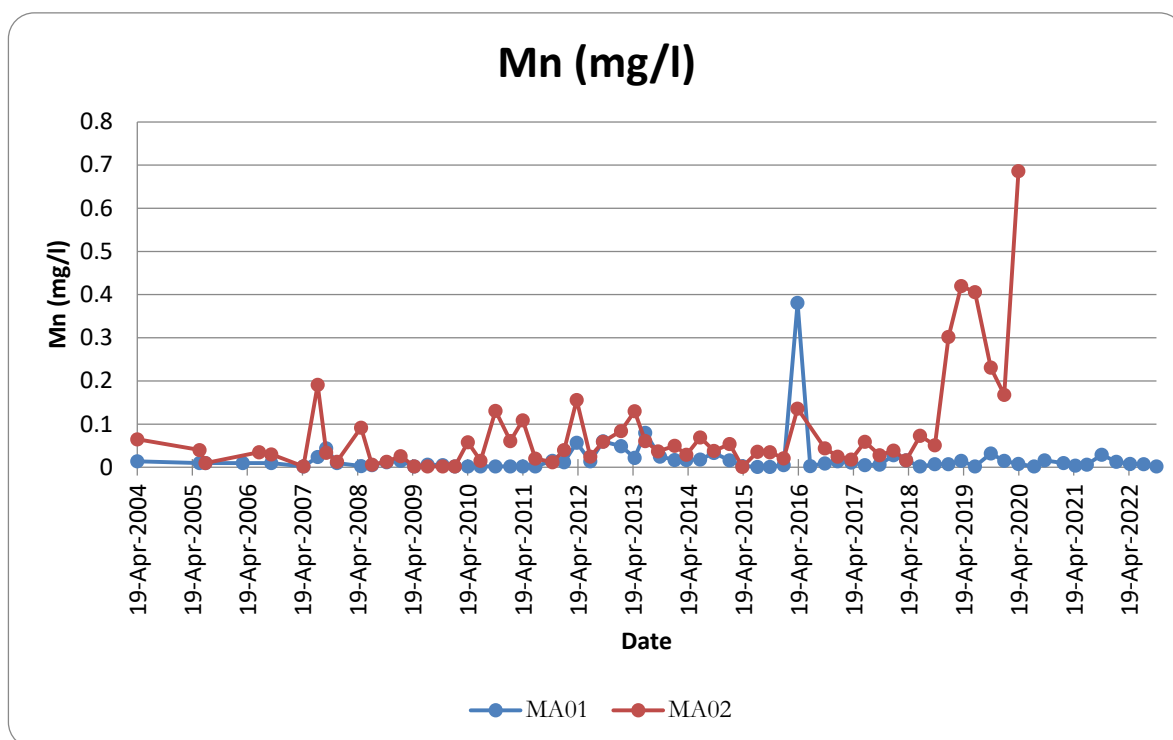


Figure 39: Mn Concentration timeseries within the Culvert - Inlet

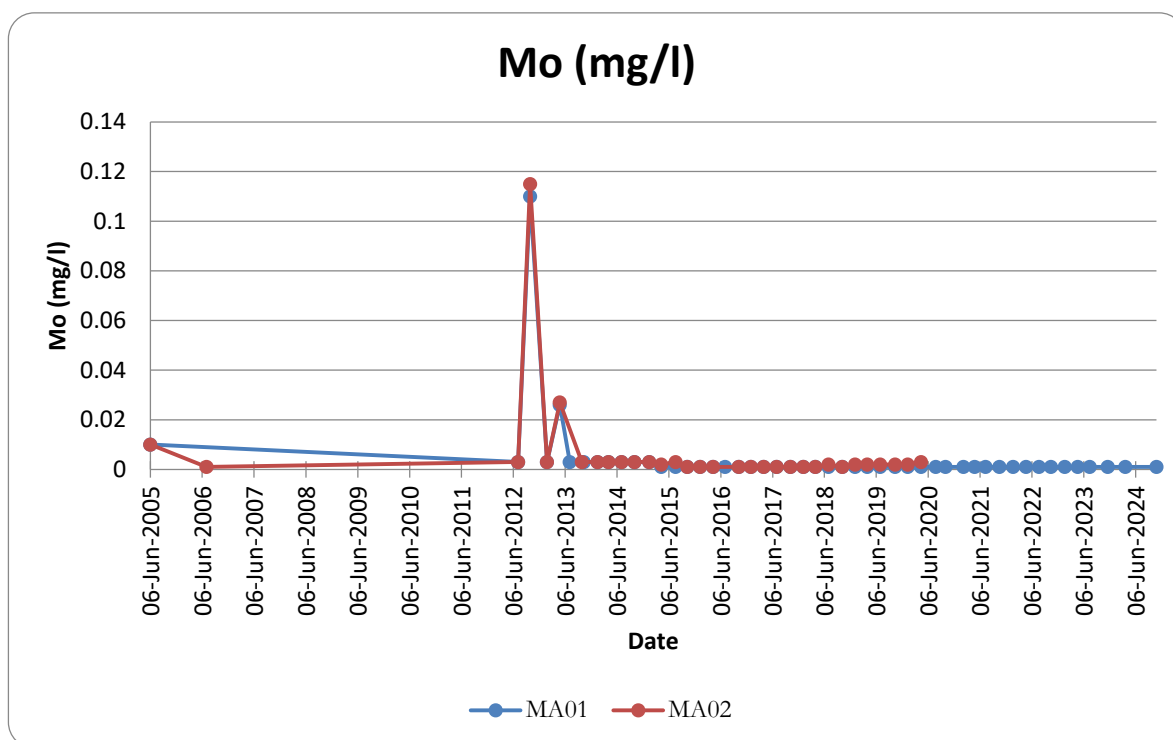


Figure 40: Mo Concentration timeseries within the Culvert - Inlet

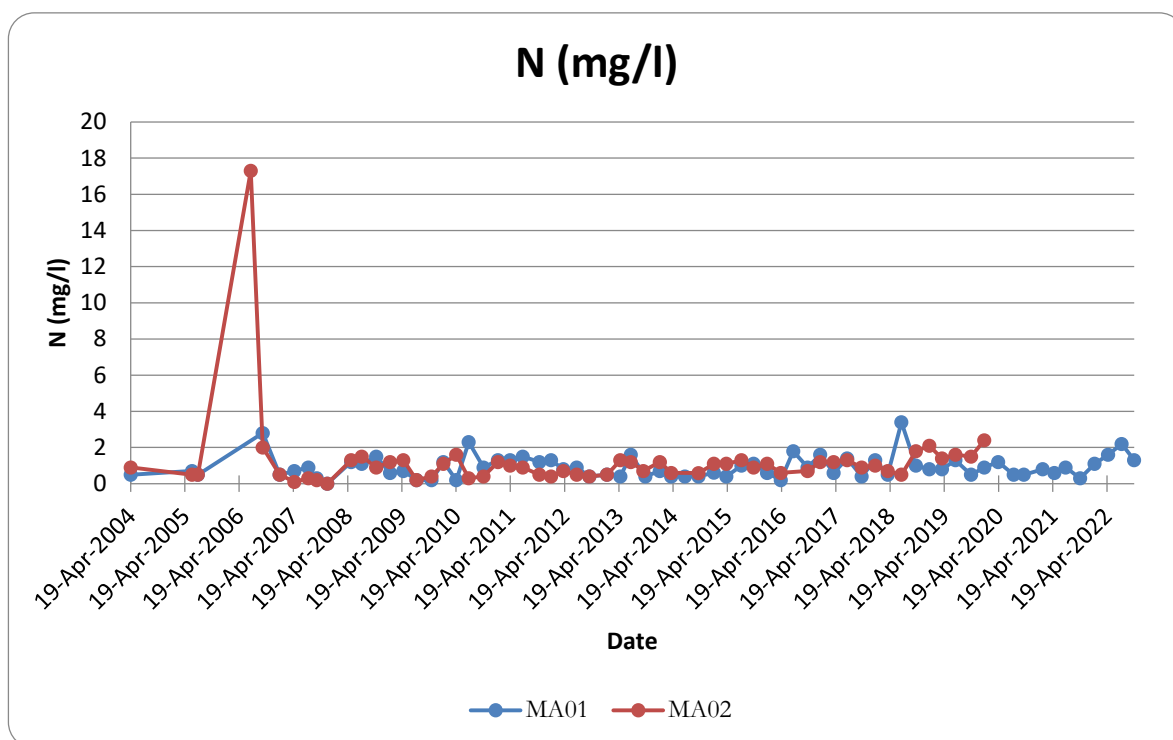


Figure 41: N Concentration timeseries within the Culvert - Inlet

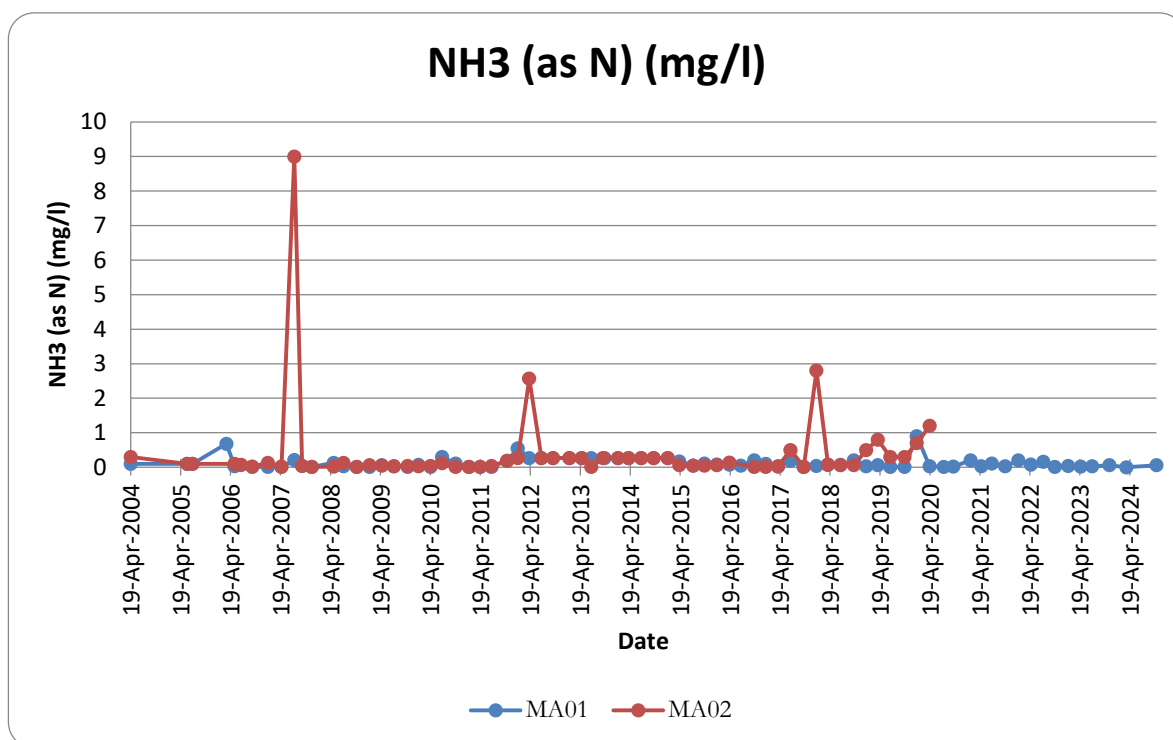


Figure 42: NH3 (as N) Concentration timeseries within the Culvert - Inlet

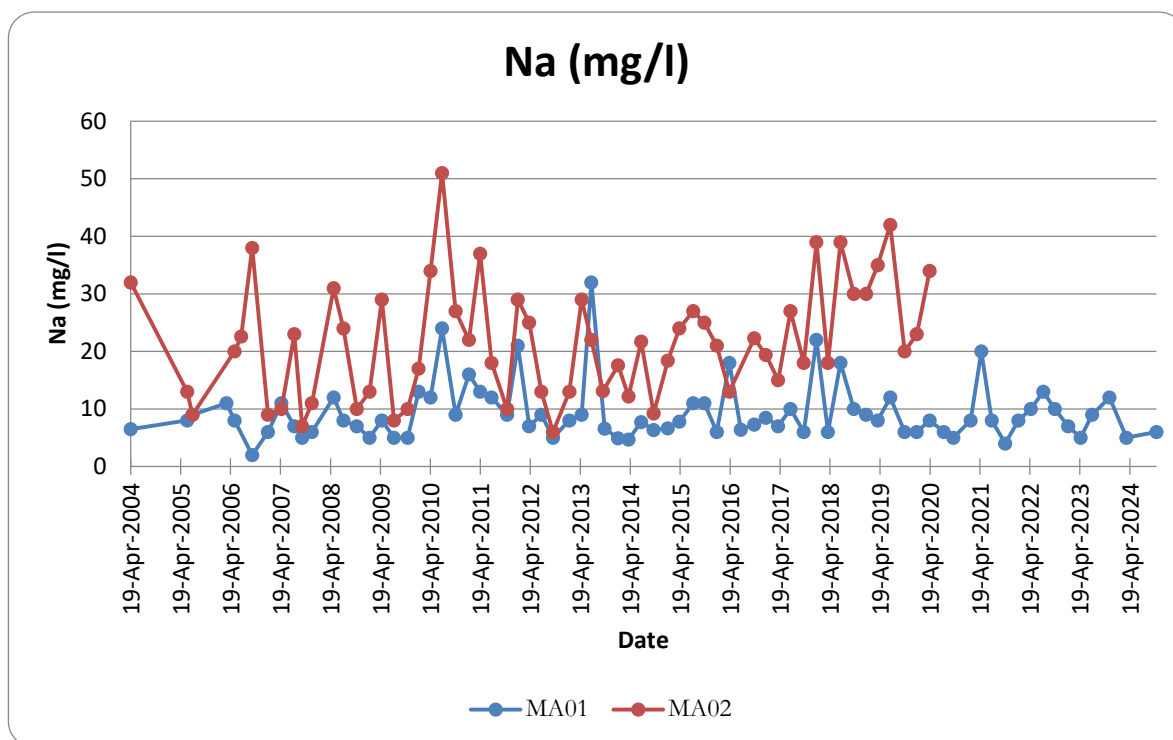


Figure 43: Na Concentration timeseries within the Culvert - Inlet

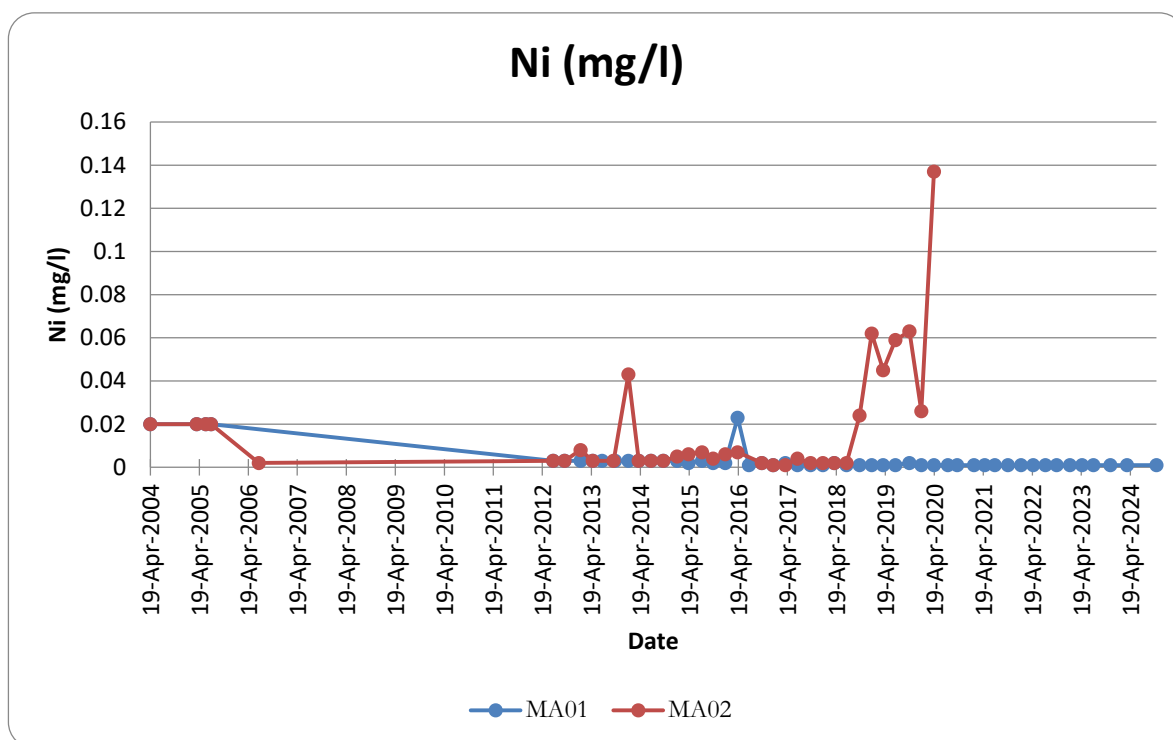


Figure 44: Ni Concentration timeseries within the Culvert - Inlet

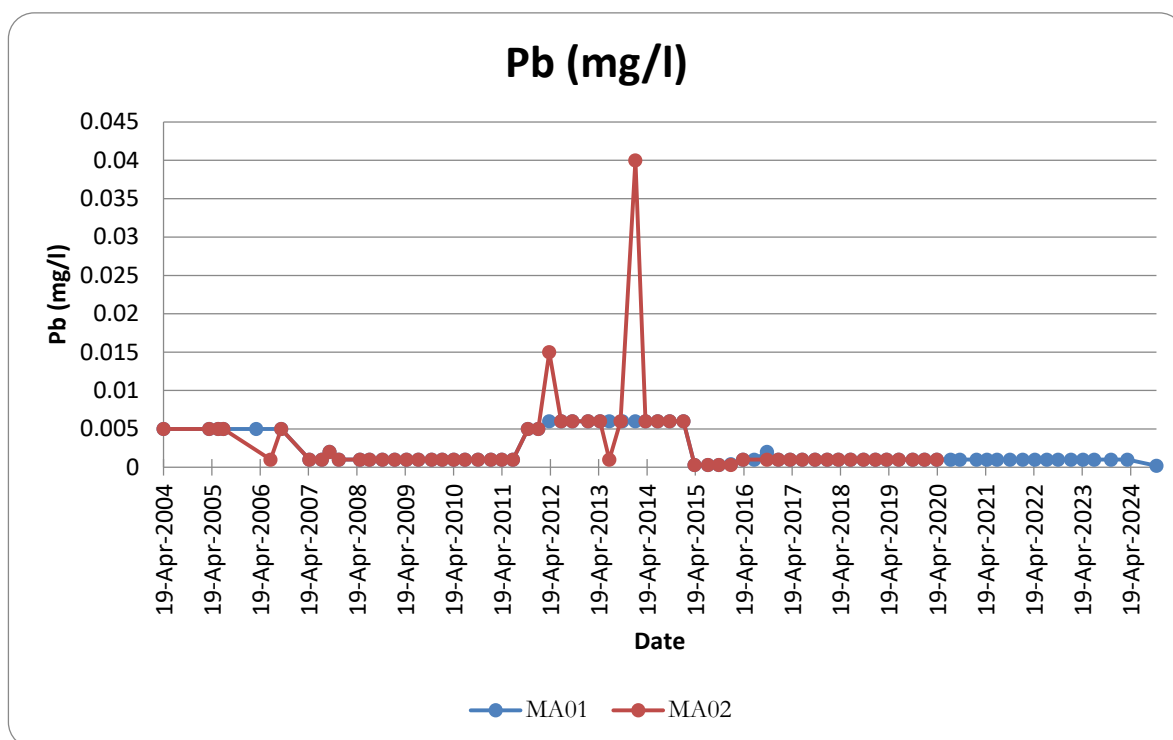


Figure 45: Pb Concentration timeseries within the Culvert - Inlet

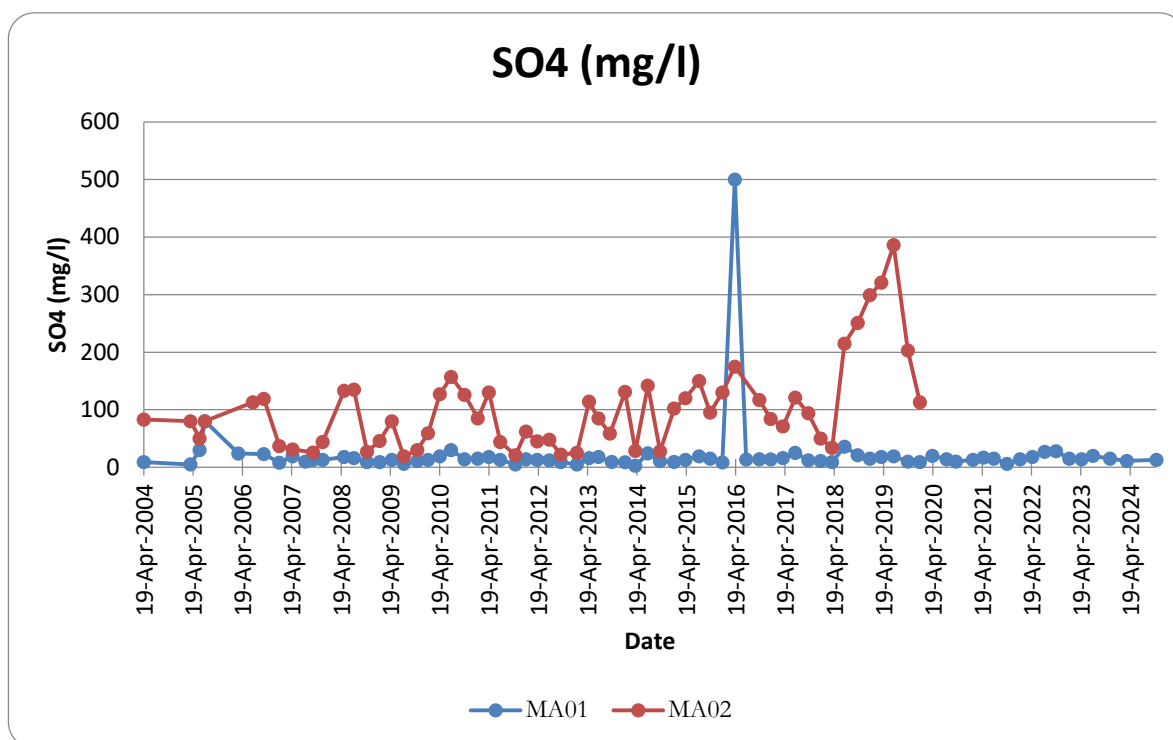
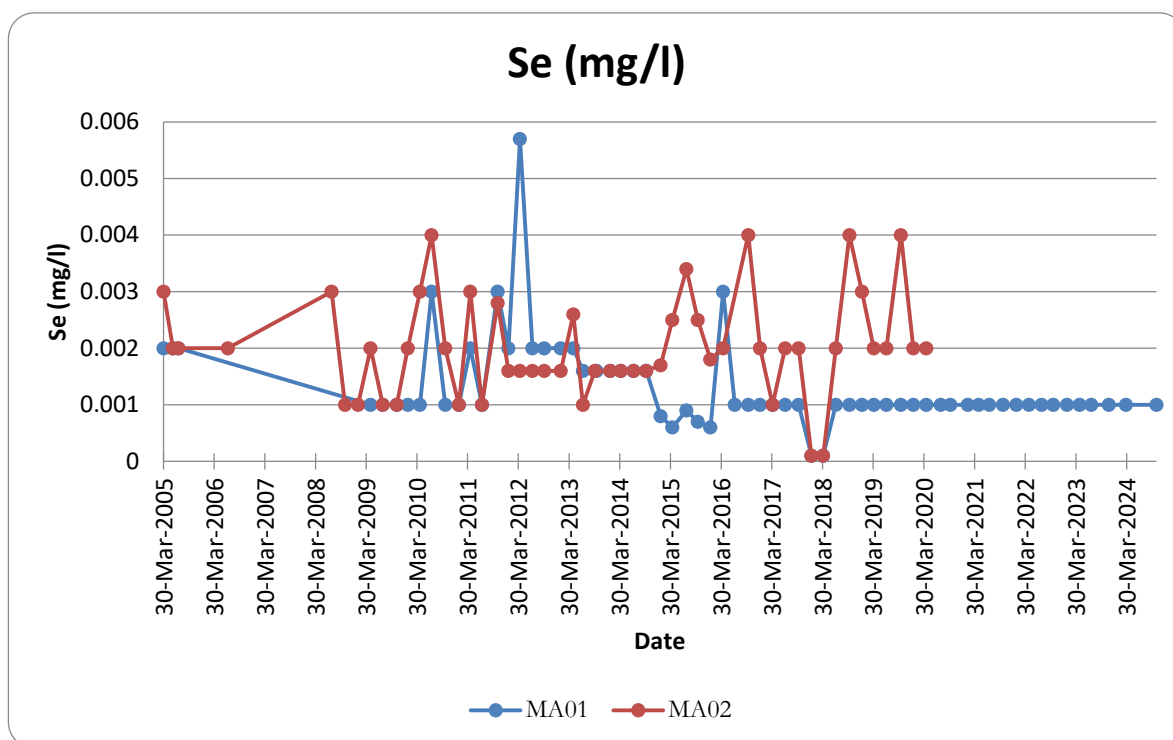
Figure 46: SO<sub>4</sub> Concentration timeseries within the Culvert - Inlet

Figure 47: Se Concentration timeseries within the Culvert - Inlet

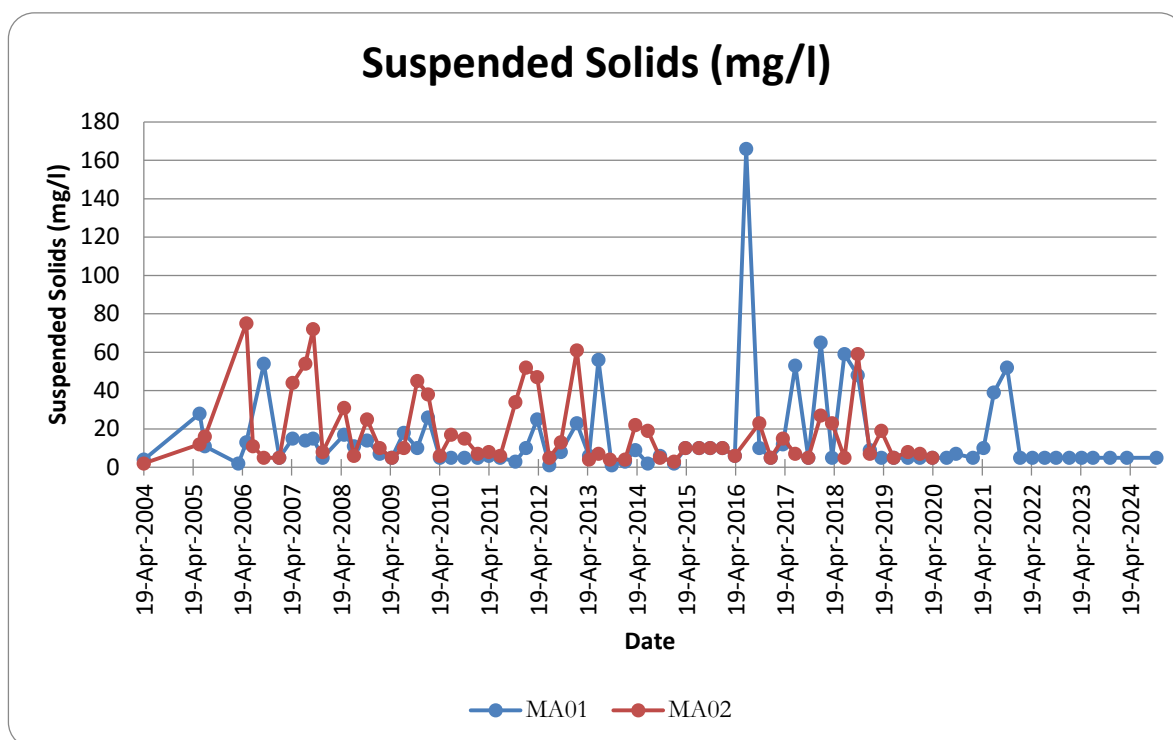


Figure 48: Suspended Solids Concentration timeseries within the Culvert - Inlet

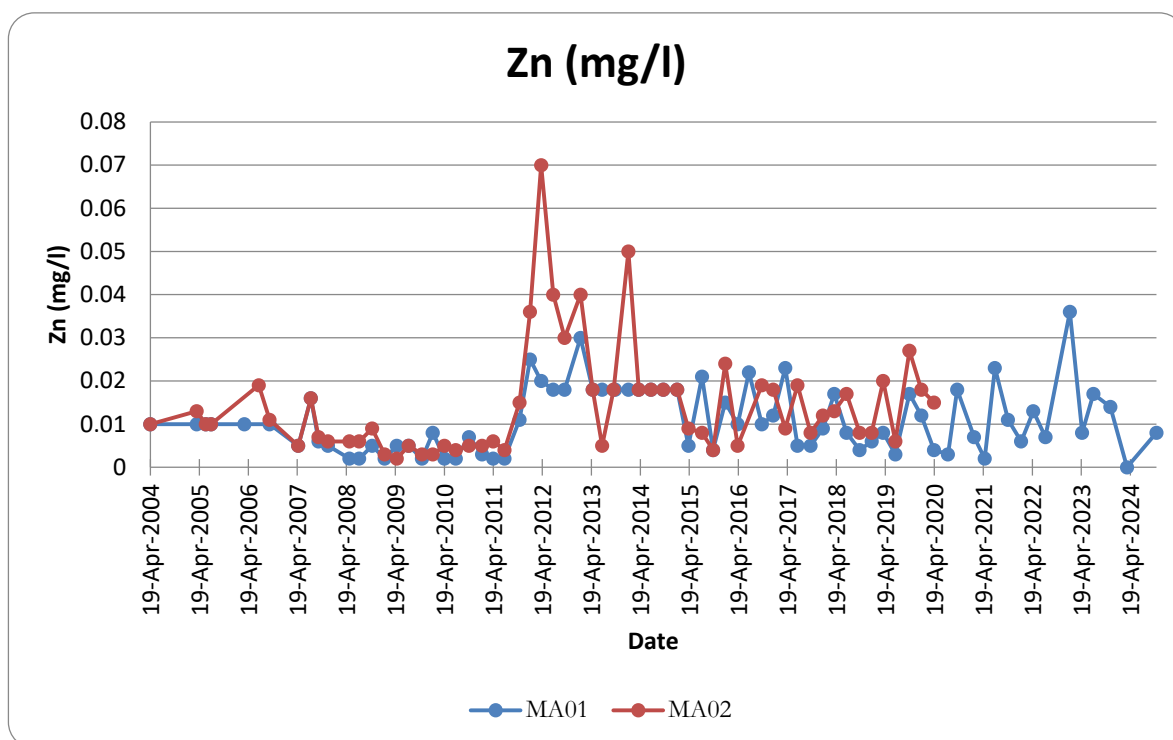


Figure 49: Zn Concentration timeseries within the Culvert - Inlet

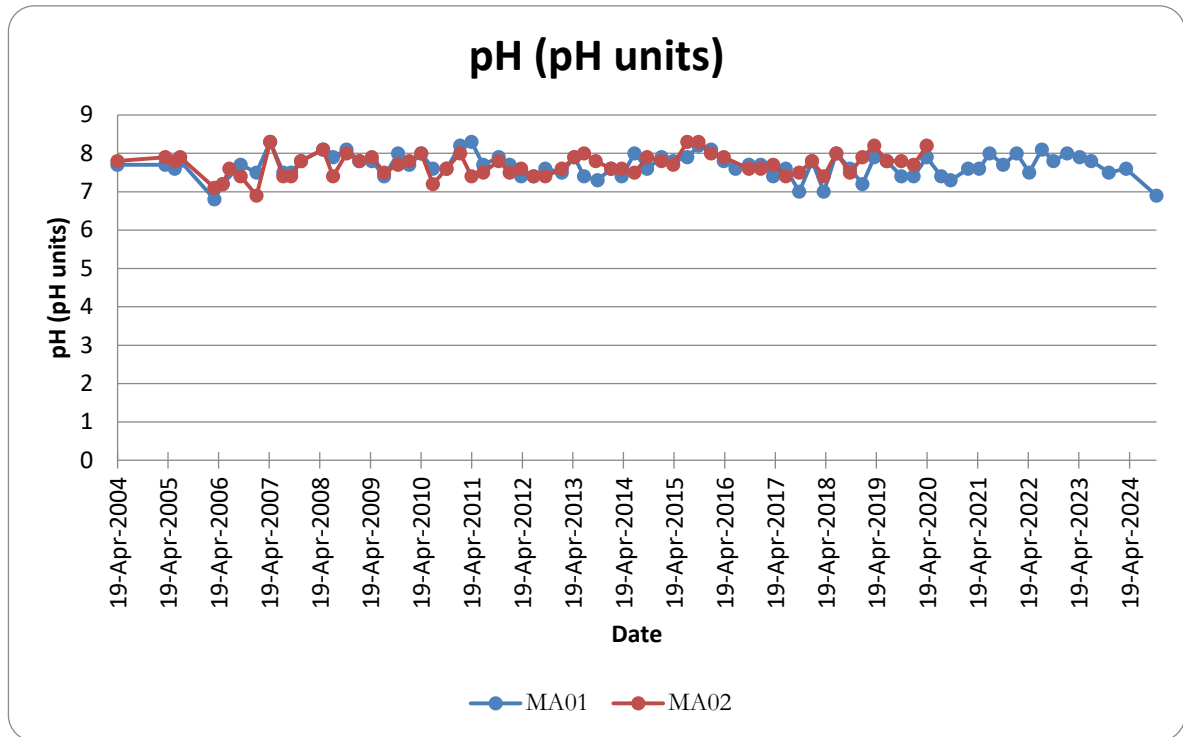


Figure 50: pH Concentration timeseries within the Culvert - Inlet

## 4 CULVERT - OUTFALL

Table 4 Culvert Outfall Monitoring Point Statistics

| Parameter    | Units | Stat  | MA03     |
|--------------|-------|-------|----------|
| Al           | mg/l  | min   | 0.006    |
|              |       | max   | 0.902    |
|              |       | mean  | 0.06798  |
|              |       | count | 57       |
| Alkalinity   | mg/l  | min   | 69       |
|              |       | max   | 351      |
|              |       | mean  | 188.19   |
|              |       | count | 50       |
| As           | mg/l  | min   | 0.0009   |
|              |       | max   | 0.01     |
|              |       | mean  | 0.0021   |
|              |       | count | 35       |
| Ca           | mg/l  | min   | 28       |
|              |       | max   | 206      |
|              |       | mean  | 84.037   |
|              |       | count | 59       |
| Cd           | mg/l  | min   | 0.00002  |
|              |       | max   | 0.002    |
|              |       | mean  | 0.00045  |
|              |       | count | 36       |
| Cl           | mg/l  | min   | 8        |
|              |       | max   | 82       |
|              |       | mean  | 37.3     |
|              |       | count | 58       |
| Conductivity | mS/cm | min   | 200      |
|              |       | max   | 1590     |
|              |       | mean  | 668.0943 |
|              |       | count | 53       |
| Cr           | mg/l  | min   | 0.001    |
|              |       | max   | 0.01     |
|              |       | mean  | 0.0022   |
|              |       | count | 35       |
| Cu           | mg/l  | min   | 0.001    |
|              |       | max   | 0.033    |
|              |       | mean  | 0.00471  |
|              |       | count | 58       |
| Fe           | mg/l  | min   | 0.01     |
|              |       | max   | 1.13     |
|              |       | mean  | 0.2378   |
|              |       | count | 58       |
| Hg           | mg/l  | min   | 0.00003  |
|              |       | max   | 0.001    |
|              |       | mean  | 0.00017  |
|              |       | count | 35       |
| K            | mg/l  | min   | 3        |
|              |       | max   | 59       |
|              |       | mean  | 14       |
|              |       | count | 58       |
| Mg           | mg/l  | min   | 2        |
|              |       | max   | 105      |
|              |       | mean  | 26.939   |
|              |       | count | 58       |



| Parameter        | Units    | Stat  | MA03    |
|------------------|----------|-------|---------|
| Mn               | mg/l     | min   | 0.002   |
|                  |          | max   | 1.26    |
|                  |          | mean  | 0.0954  |
|                  |          | count | 57      |
| Mo               | mg/l     | min   | 0.001   |
|                  |          | max   | 0.126   |
|                  |          | mean  | 0.007   |
|                  |          | count | 33      |
| N                | mg/l     | min   | 0       |
|                  |          | max   | 5       |
|                  |          | mean  | 1.1     |
|                  |          | count | 58      |
| NH3 (as N)       | mg/l     | min   | 0.01    |
|                  |          | max   | 8       |
|                  |          | mean  | 0.4     |
|                  |          | count | 59      |
| Na               | mg/l     | min   | 7       |
|                  |          | max   | 98      |
|                  |          | mean  | 23.82   |
|                  |          | count | 59      |
| Ni               | mg/l     | min   | 0.001   |
|                  |          | max   | 0.136   |
|                  |          | mean  | 0.01506 |
|                  |          | count | 36      |
| Pb               | mg/l     | min   | 0.0003  |
|                  |          | max   | 0.017   |
|                  |          | mean  | 0.00268 |
|                  |          | count | 58      |
| SO4              | mg/l     | min   | 14      |
|                  |          | max   | 445     |
|                  |          | mean  | 125.19  |
|                  |          | count | 59      |
| Se               | mg/l     | min   | 0.0001  |
|                  |          | max   | 0.021   |
|                  |          | mean  | 0.00242 |
|                  |          | count | 52      |
| Suspended Solids | mg/l     | min   | 1       |
|                  |          | max   | 78      |
|                  |          | mean  | 15.41   |
|                  |          | count | 59      |
| Zn               | mg/l     | min   | 0.002   |
|                  |          | max   | 0.07    |
|                  |          | mean  | 0.015   |
|                  |          | count | 58      |
| pH               | pH units | min   | 7.2     |
|                  |          | max   | 8.3     |
|                  |          | mean  | 7.721   |
|                  |          | count | 61      |

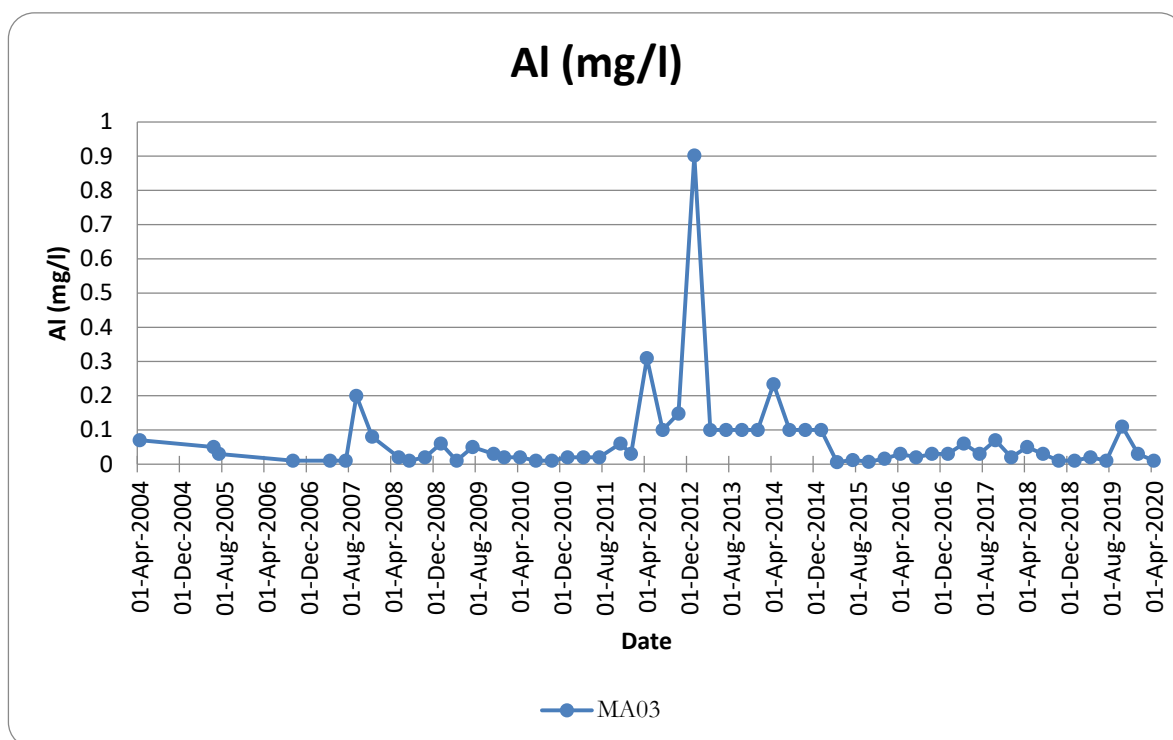


Figure 51: Al Concentration timeseries within the Culvert - Outfall

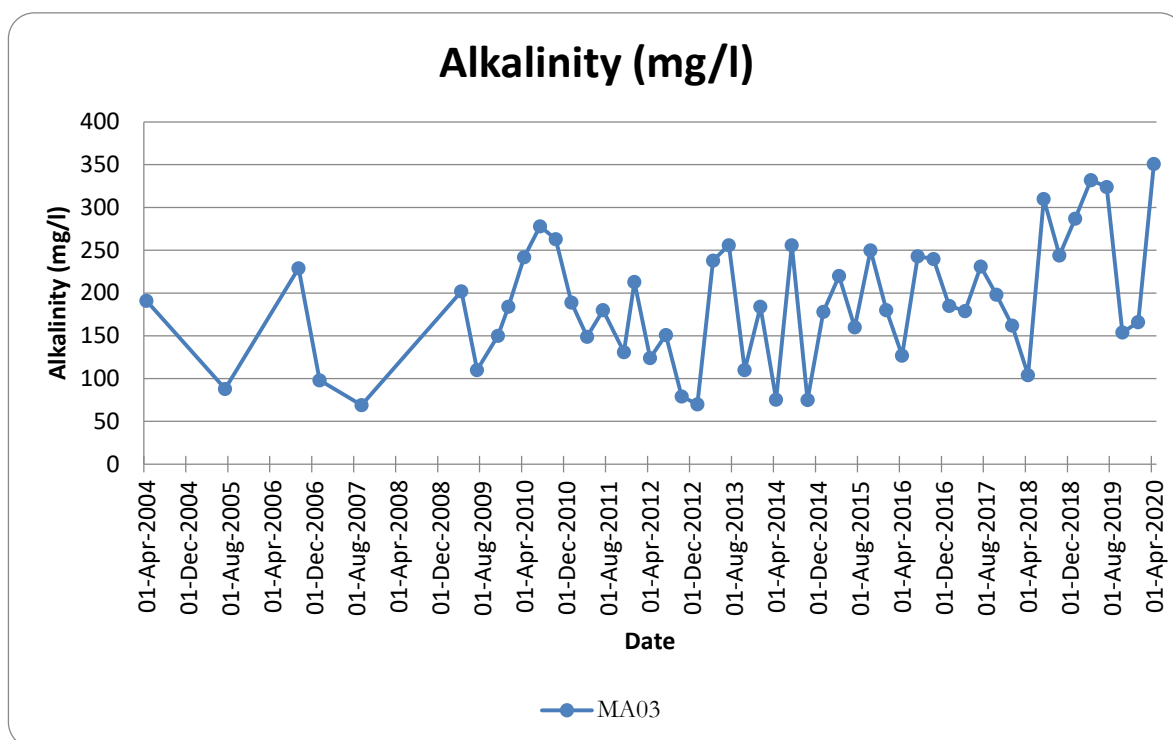


Figure 52: Alkalinity Concentration timeseries within the Culvert - Outfall

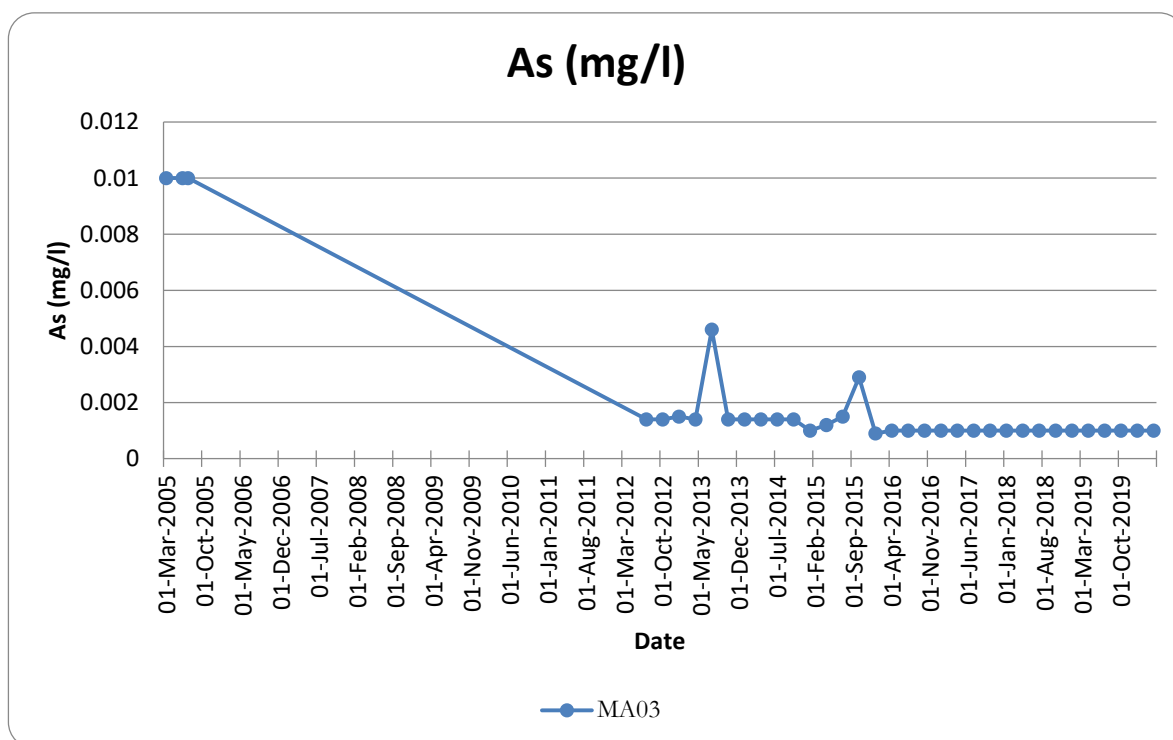


Figure 53: As Concentration timeseries within the Culvert - Outfall

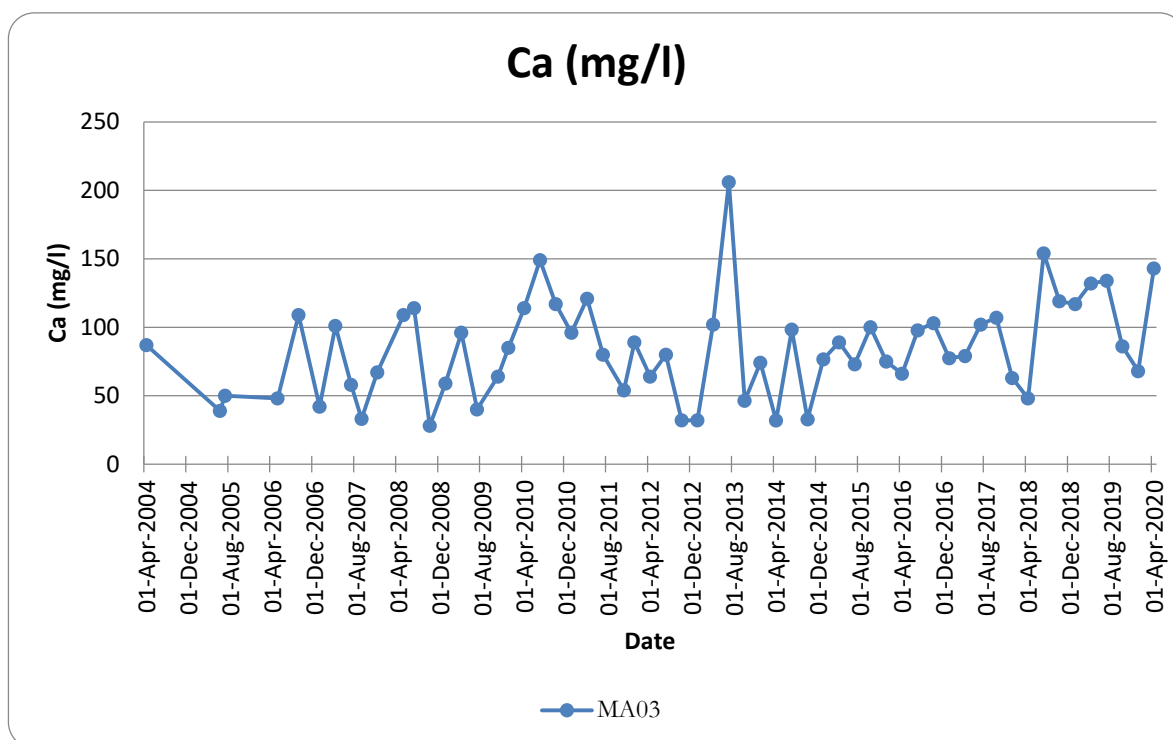


Figure 54: Ca Concentration timeseries within the Culvert - Outfall

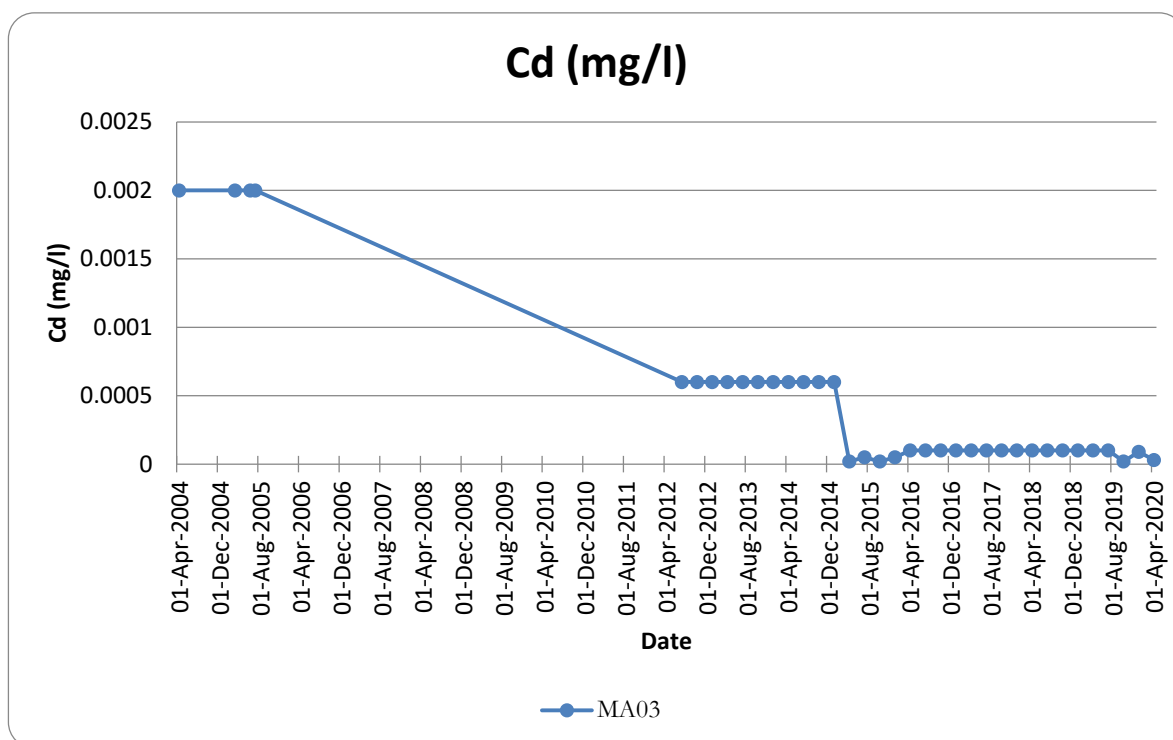


Figure 55: Cd Concentration timeseries within the Culvert - Outfall

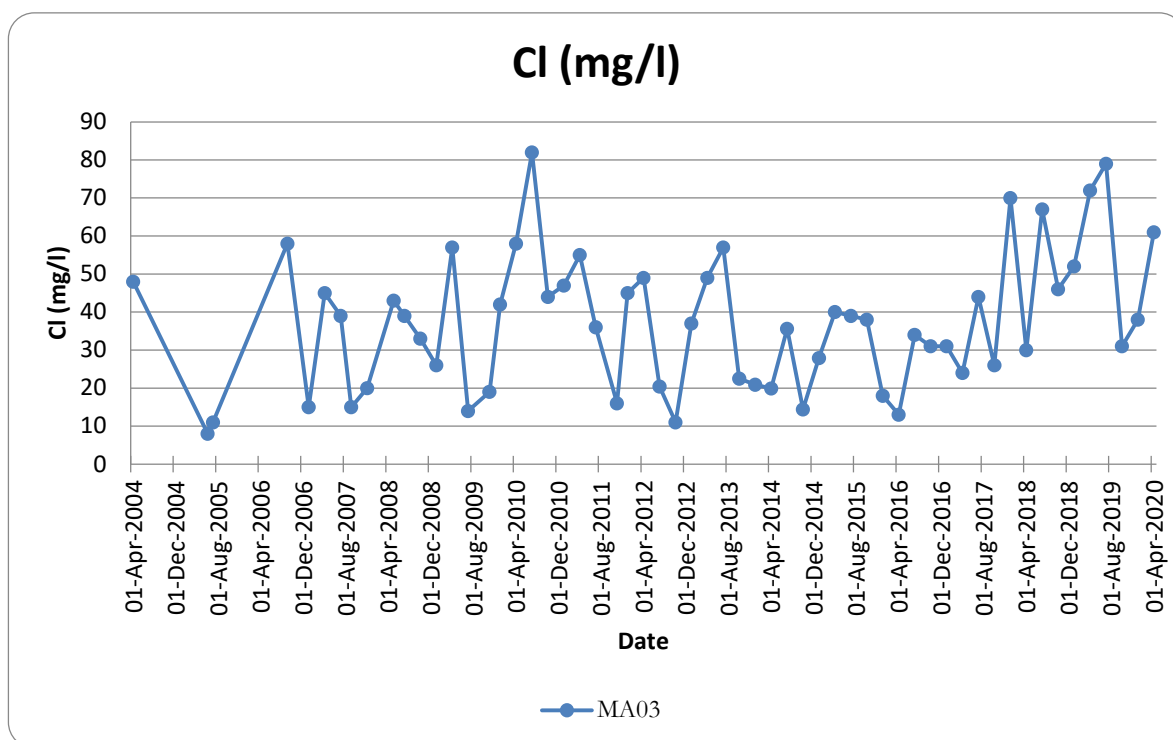


Figure 56: Cl Concentration timeseries within the Culvert - Outfall

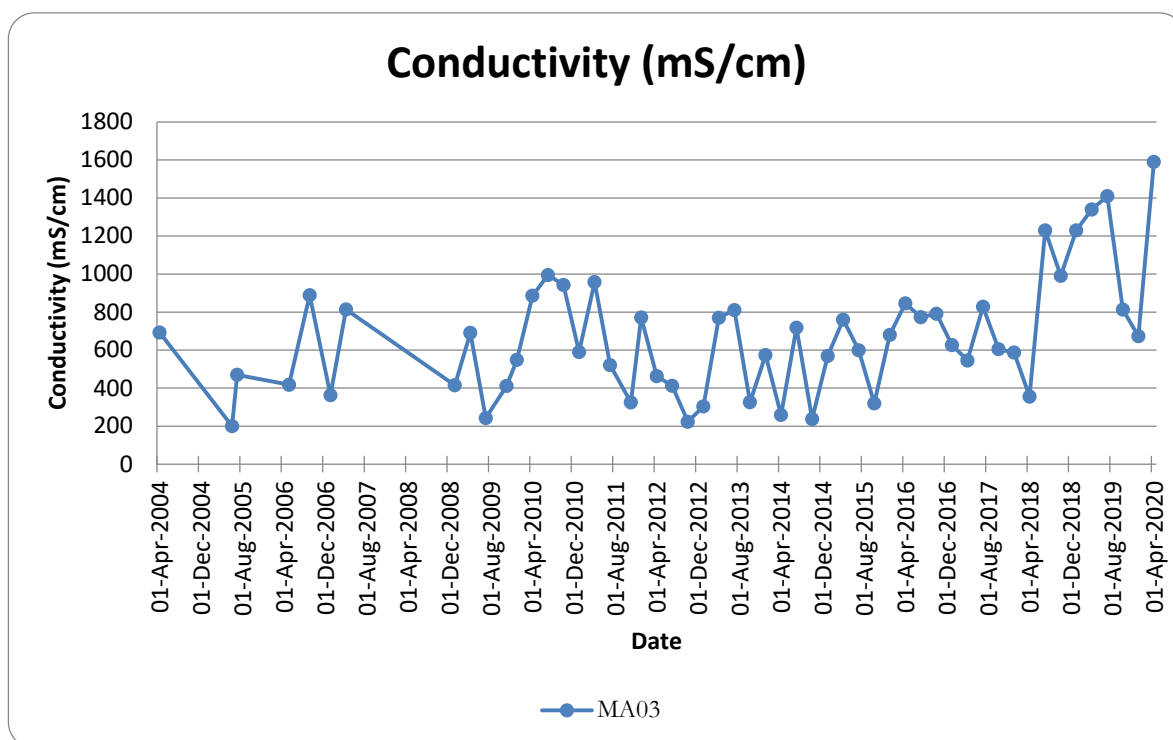


Figure 57: Electrical Conductivity timeseries within the Culvert - Outfall

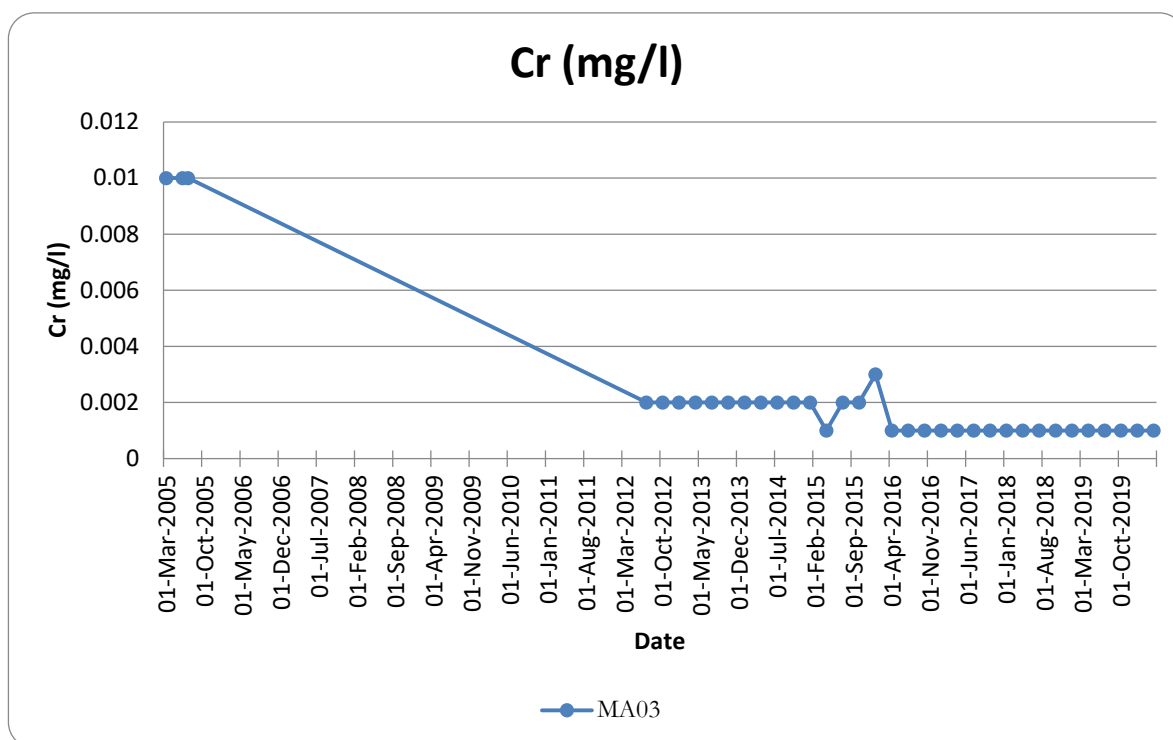


Figure 58: Cr Concentration timeseries within the Culvert - Outfall

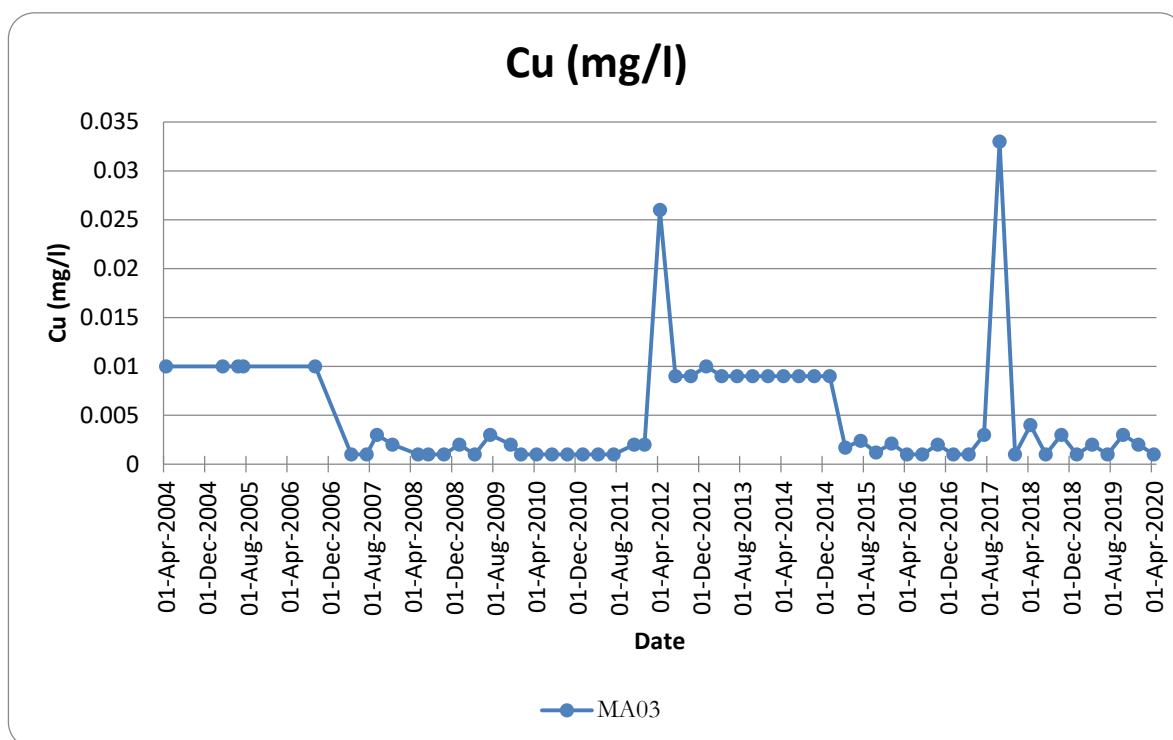


Figure 59: Cu Concentration timeseries within the Culvert - Outfall

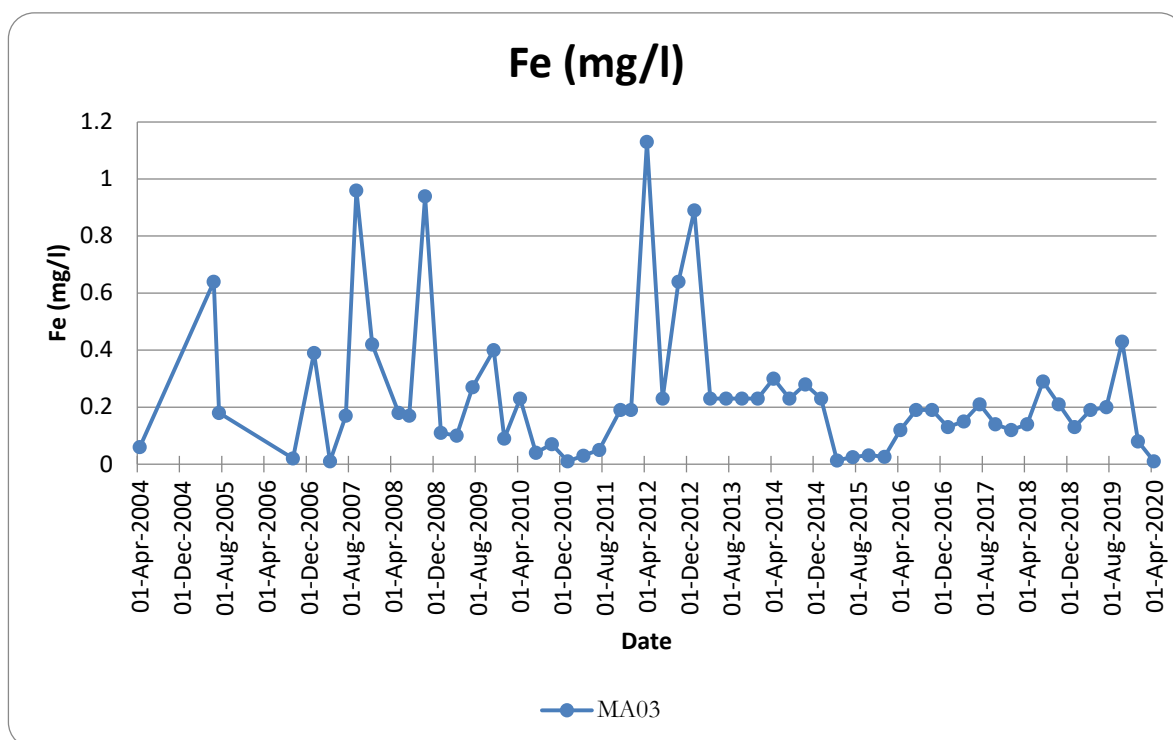


Figure 60: Fe Concentration timeseries within the Culvert - Outfall

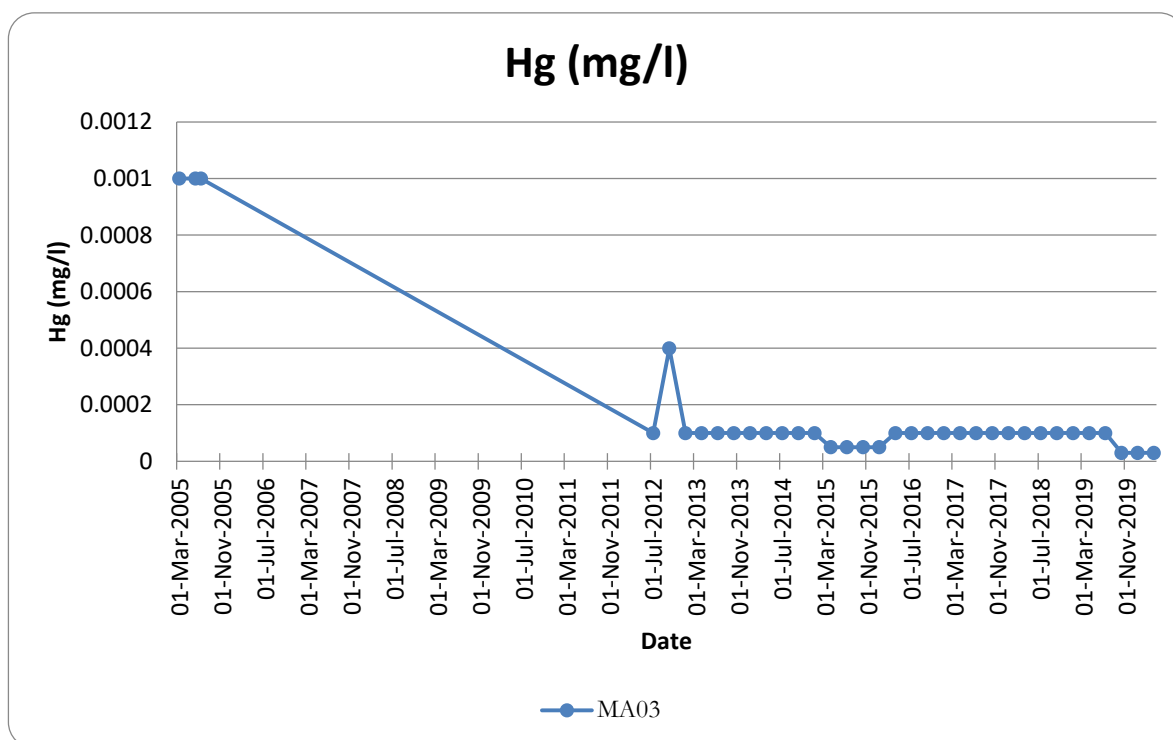


Figure 61: Hg Concentration timeseries within the Culvert - Outfall

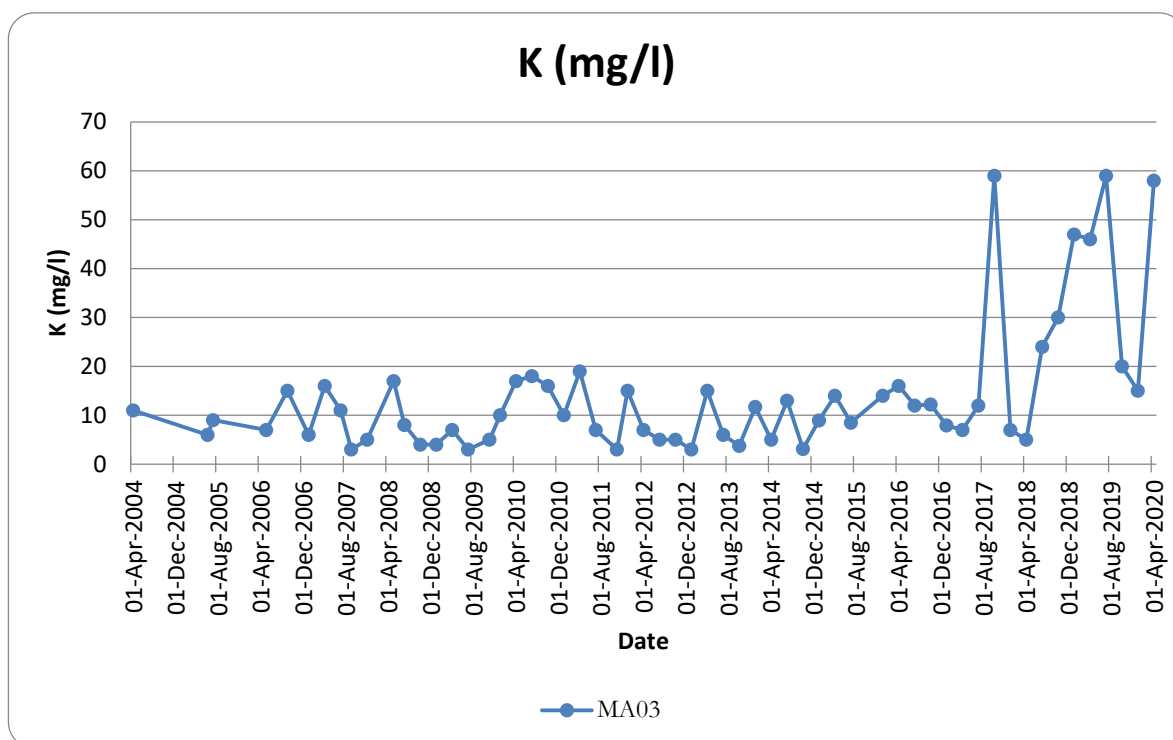


Figure 62: K Concentration timeseries within the Culvert - Outfall

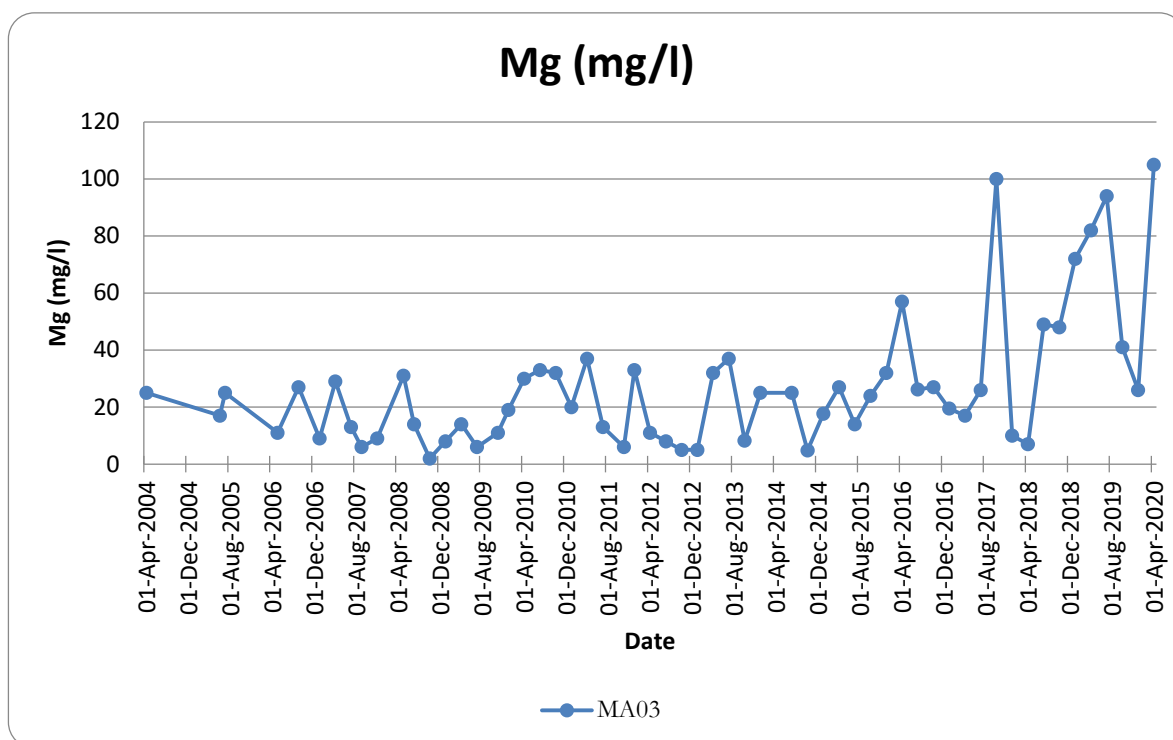


Figure 63: Mg Concentration timeseries within the Culvert - Outfall

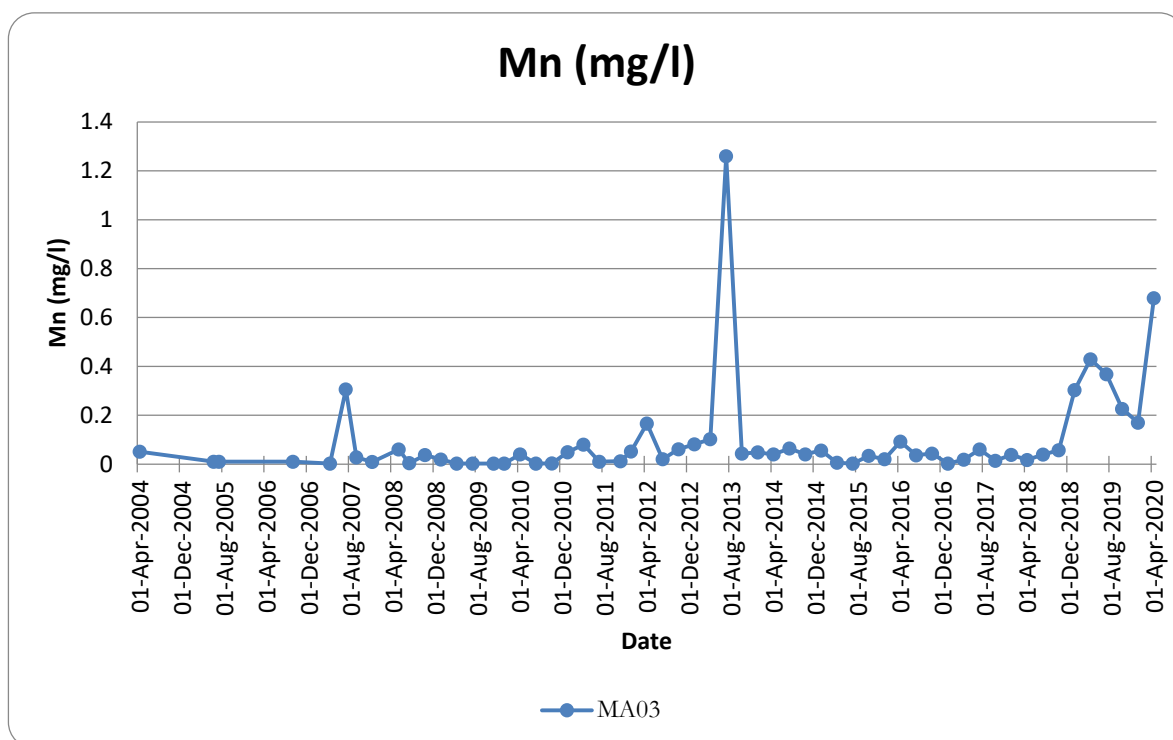


Figure 64: Mn Concentration timeseries within the Culvert - Outfall

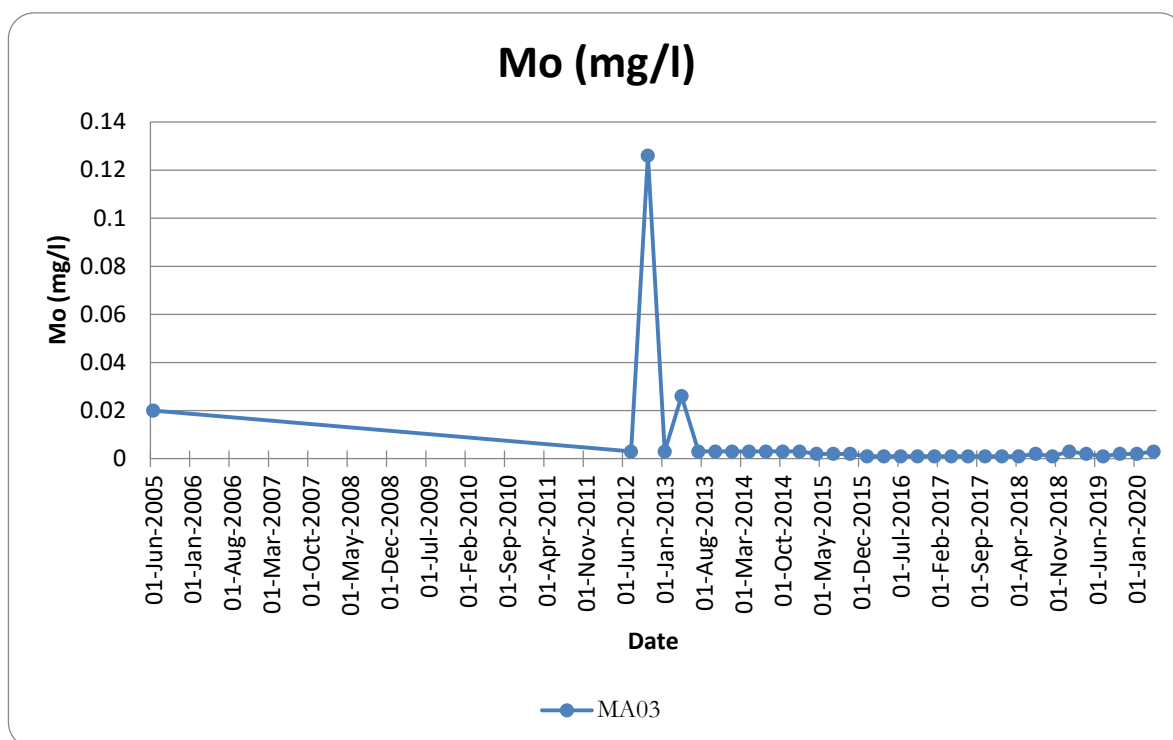


Figure 65: Mo Concentration timeseries within the Culvert - Outfall

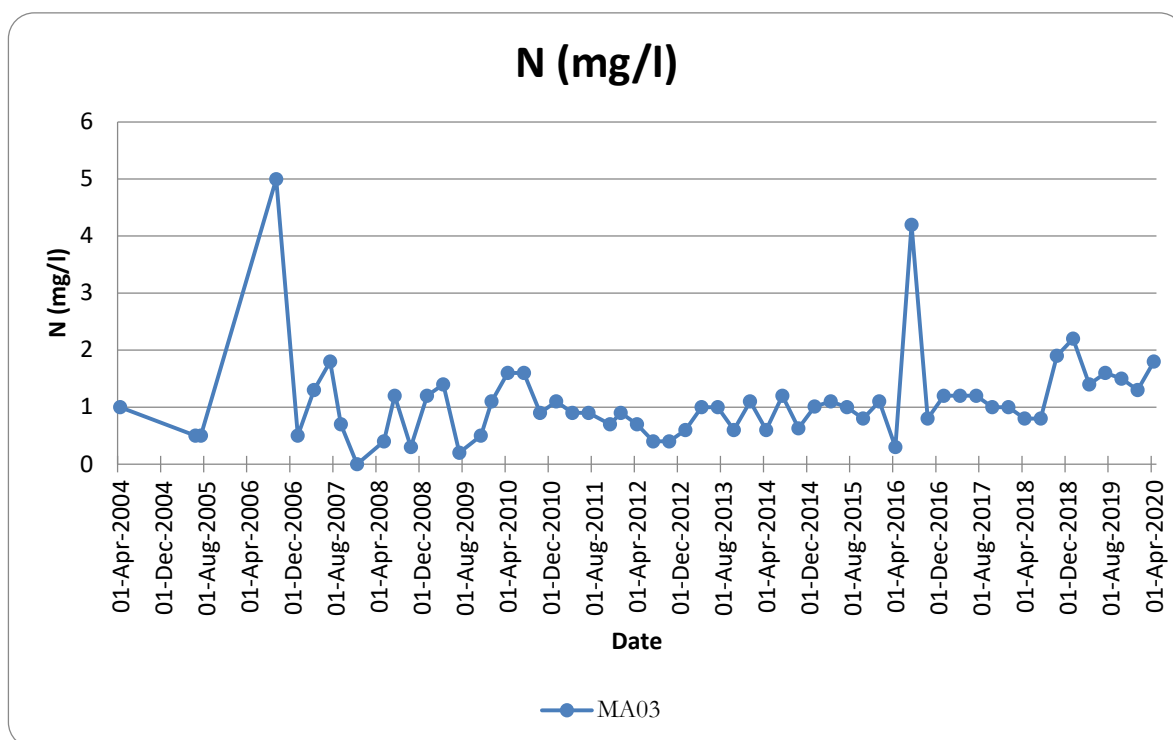


Figure 66: N Concentration timeseries within the Culvert - Outfall

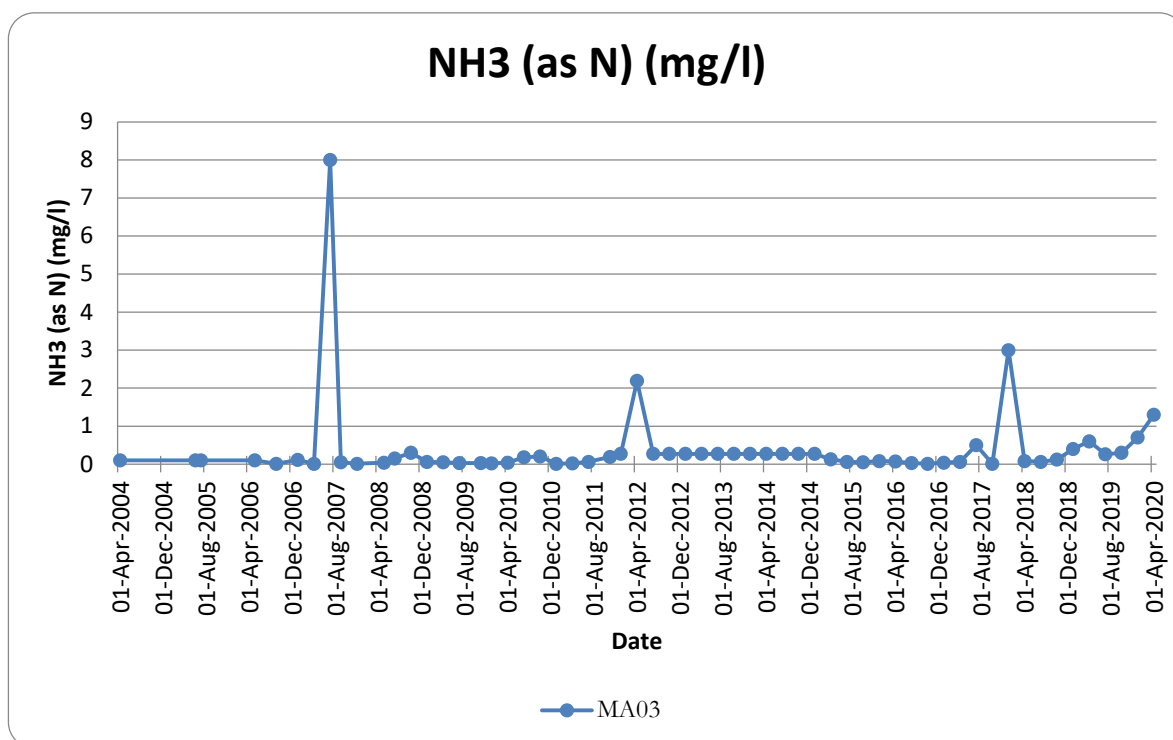


Figure 67: NH3 (as N) Concentration timeseries within the Culvert - Outfall

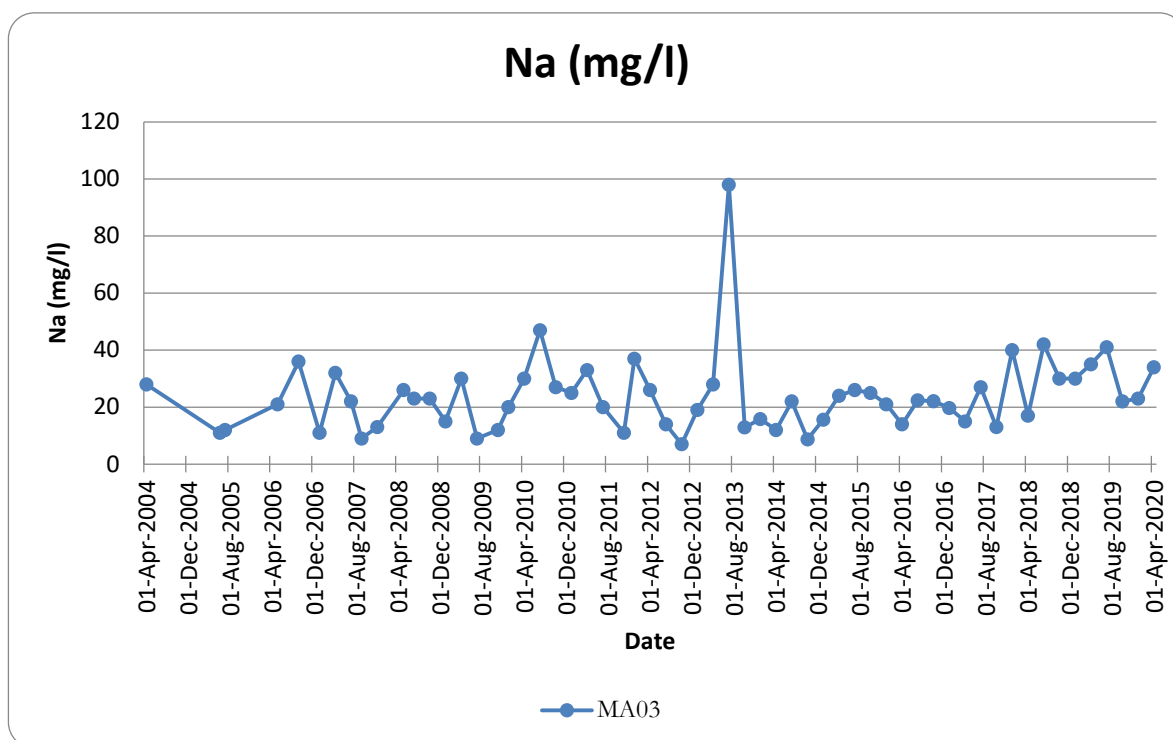


Figure 68: Na Concentration timeseries within the Culvert - Outfall

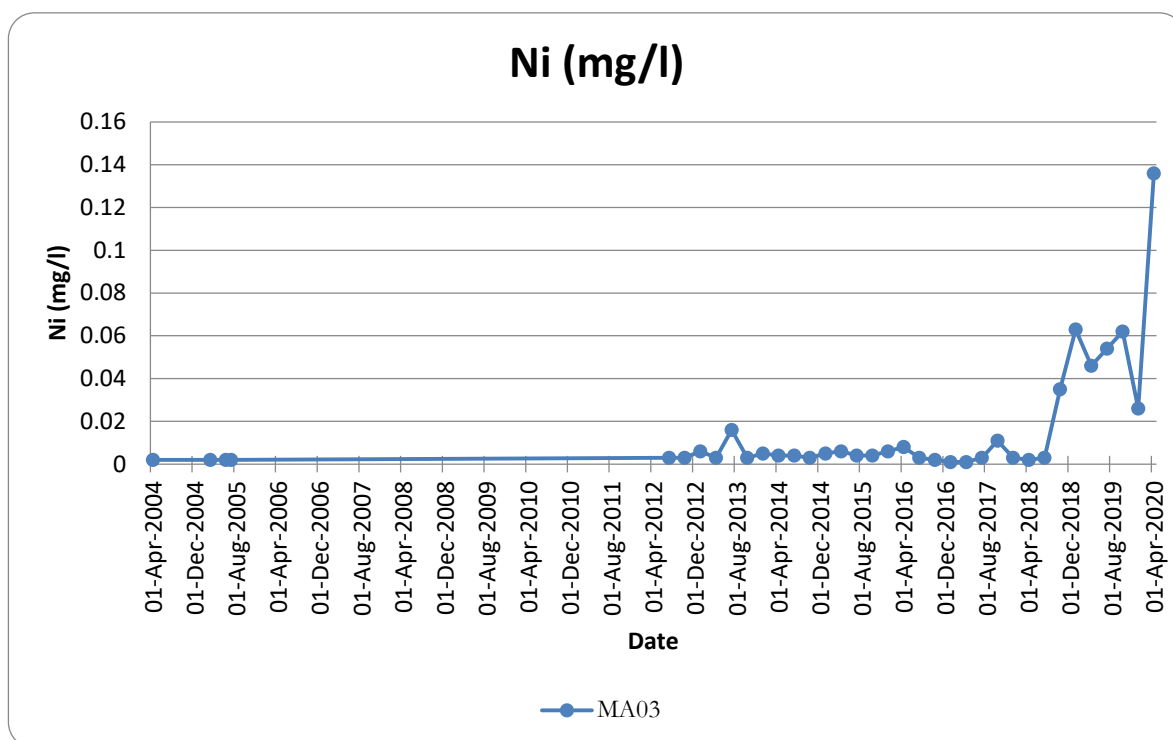


Figure 69: Ni Concentration timeseries within the Culvert - Outfall

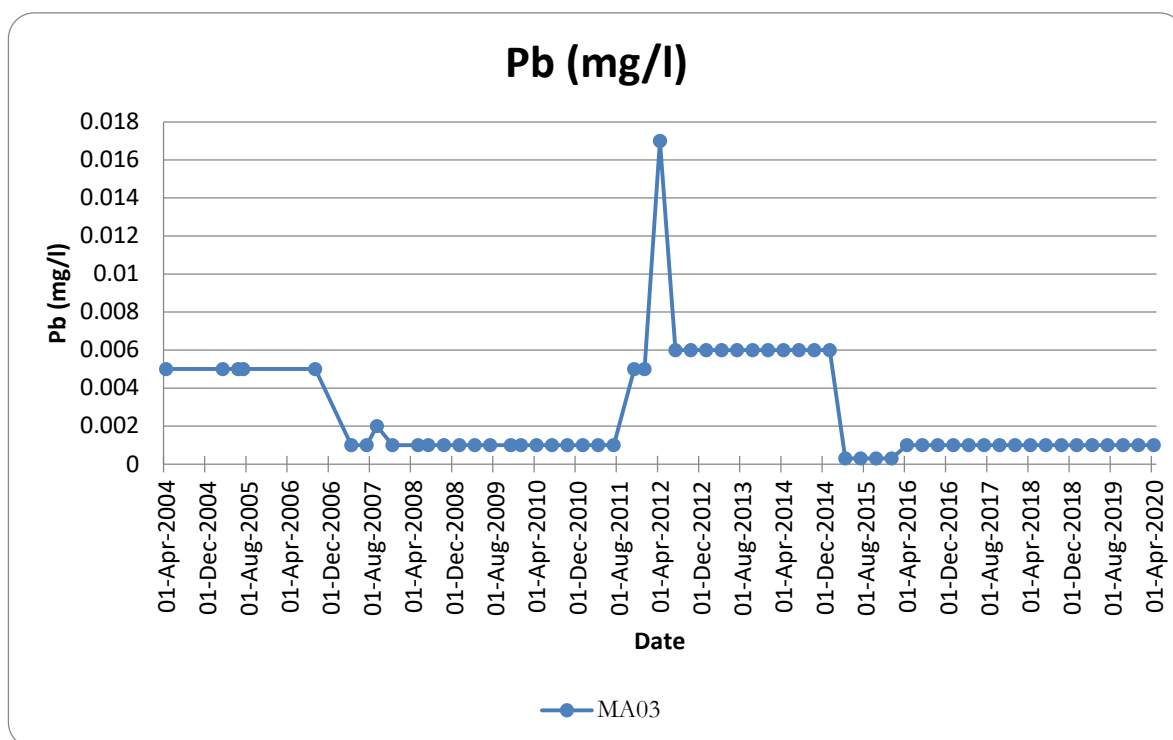


Figure 70: Pb Concentration timeseries within the Culvert - Outfall

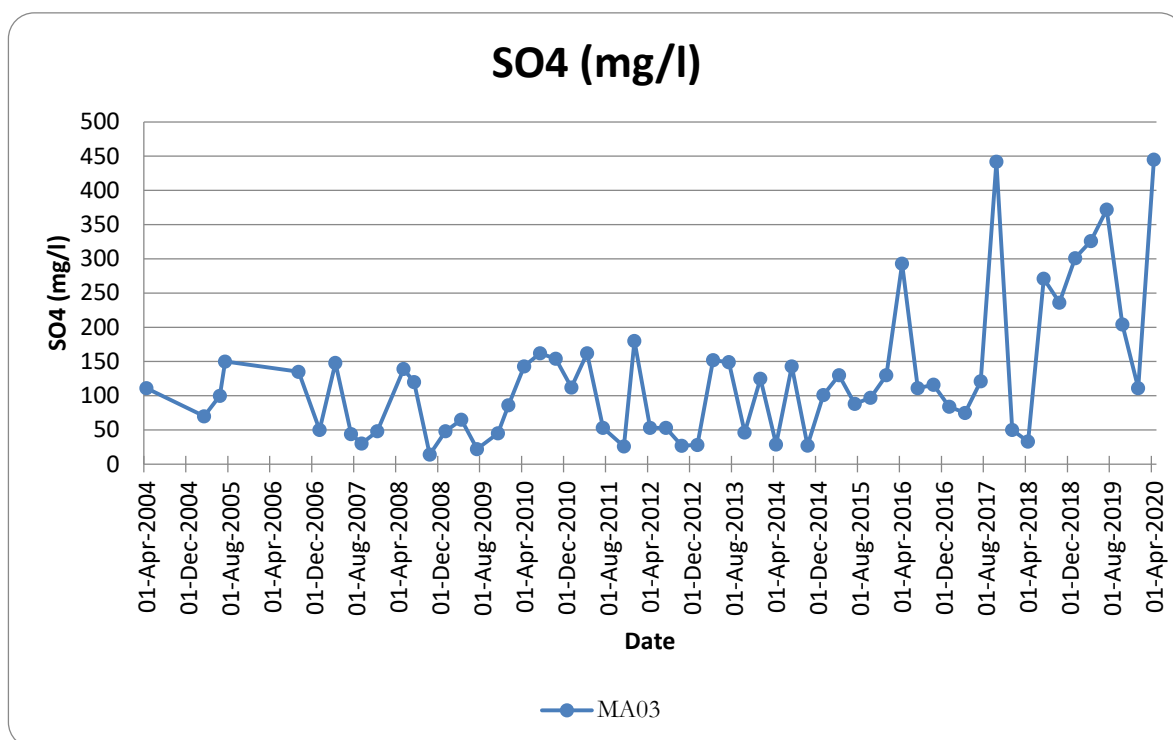
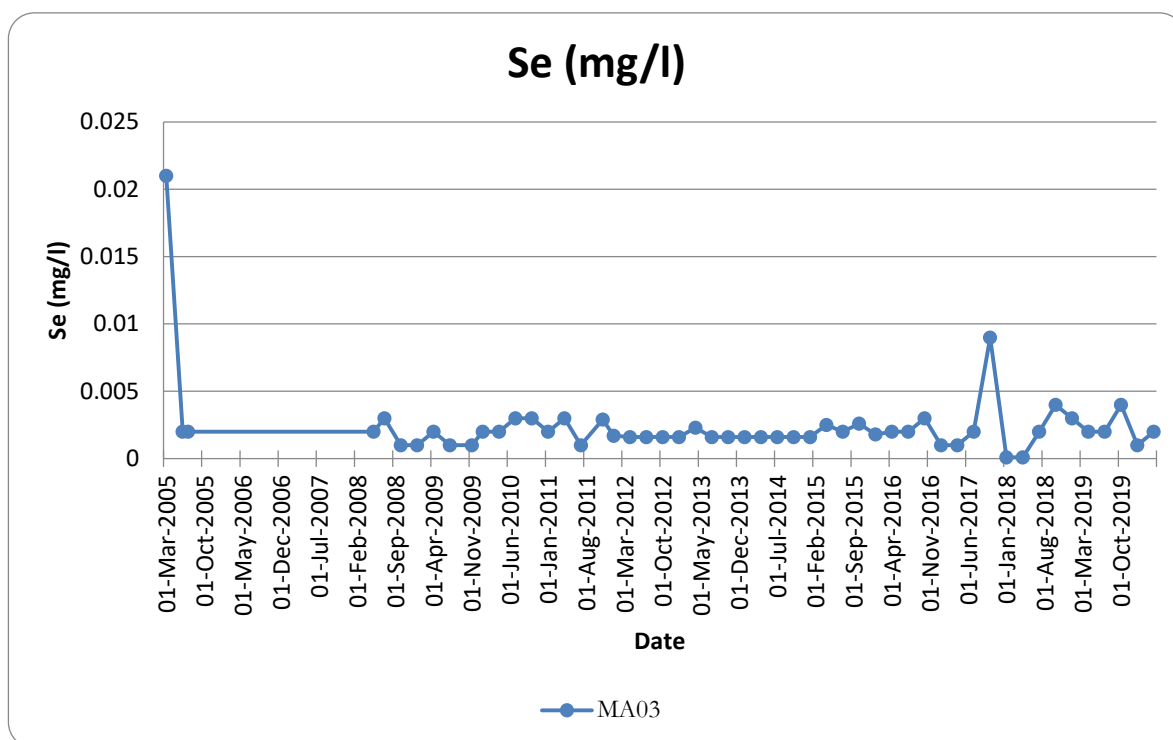
Figure 71: SO<sub>4</sub> Concentration timeseries within the Culvert - Outfall

Figure 72: Se Concentration timeseries within the Culvert - Outfall

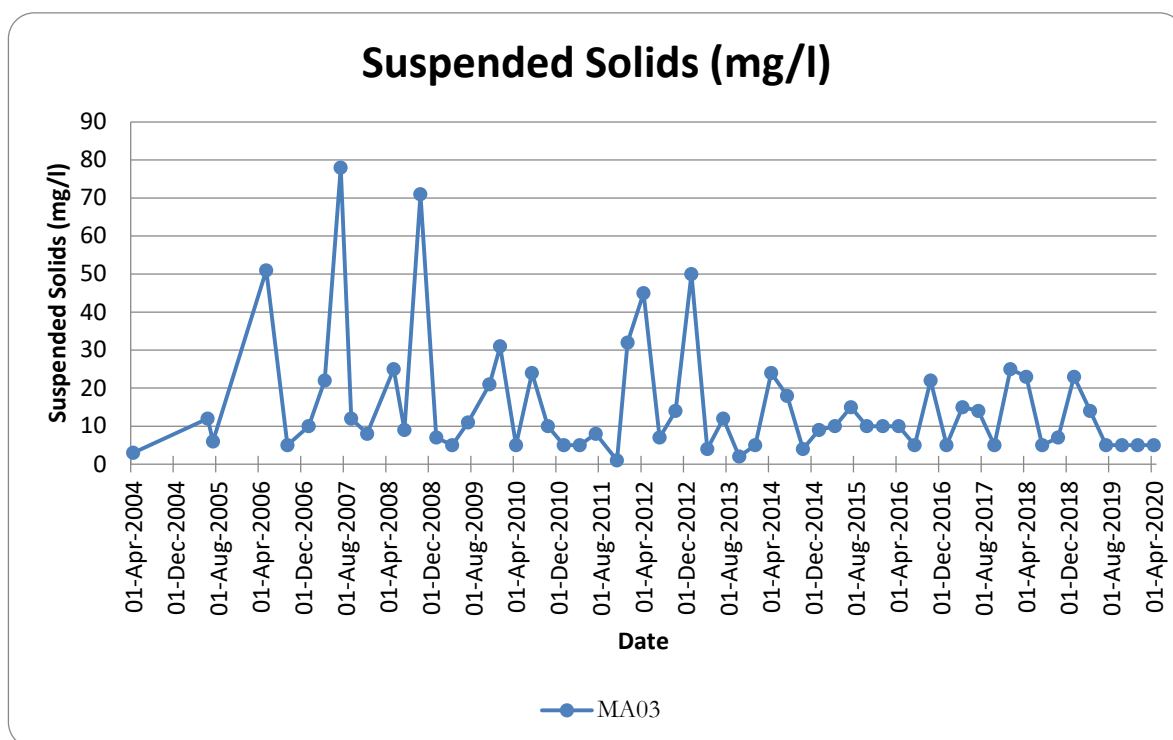


Figure 73: Suspended Solids Concentration timeseries within the Culvert - Outfall

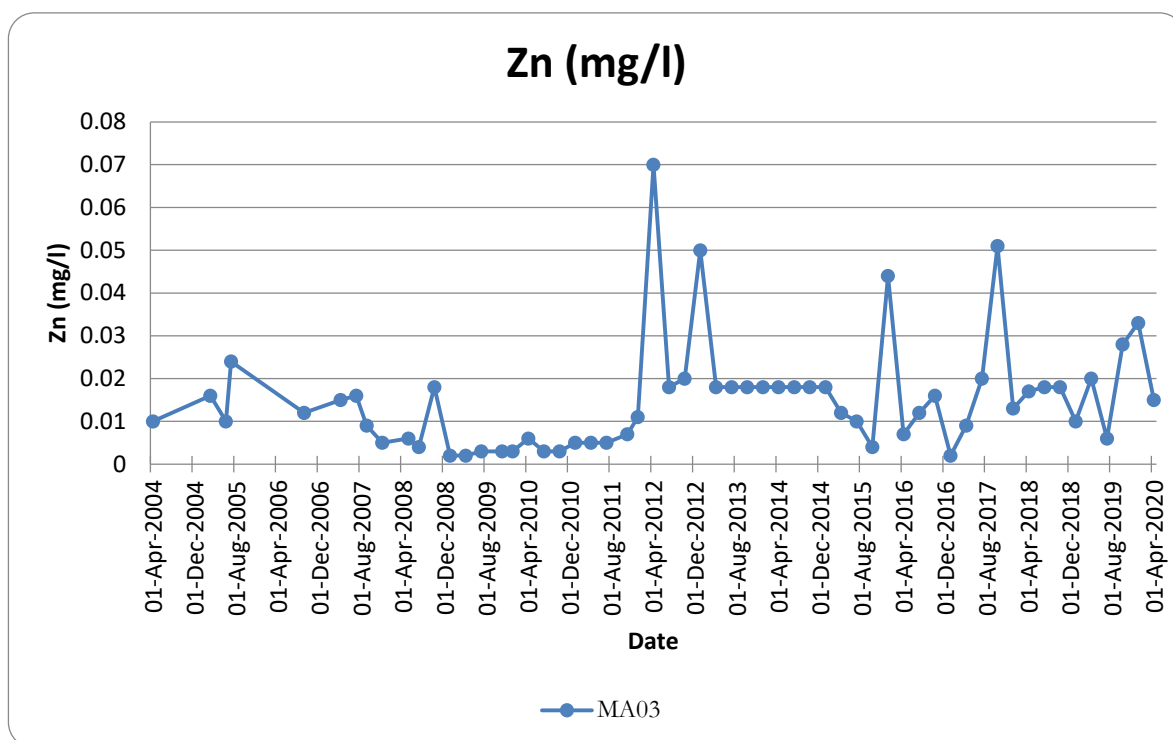


Figure 74: Zn Concentration timeseries within the Culvert - Outfall

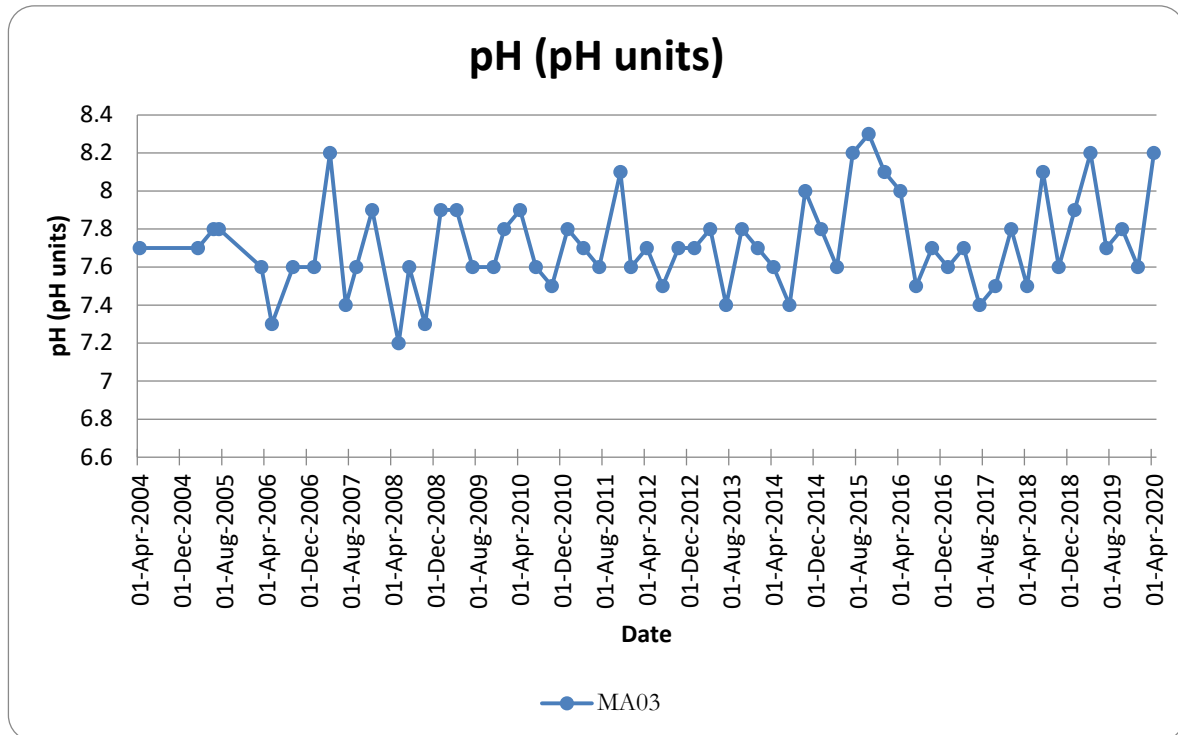


Figure 75: pH Concentration timeseries within the Culvert - Outfall

## 5 DOWLAIS FAULT

Table 5 Dowlais Fault Monitoring Point Statistics

| Parameter        | Units    | Stat  | Cwmbargoed D.P. | DP | DP Discharge | Dowlais Fault |
|------------------|----------|-------|-----------------|----|--------------|---------------|
| Fe               | mg/l     | min   | 0.01            |    | 0.01         |               |
|                  |          | max   | 0.02            |    | 0.02         |               |
|                  |          | mean  | 0.015           |    | 0.0167       |               |
|                  |          | count | 2               |    | 3            |               |
| H-3              | Bq/l     | min   |                 |    |              | 8.1           |
|                  |          | max   |                 |    |              | 8.1           |
|                  |          | mean  |                 |    |              | 8.1           |
|                  |          | count |                 |    |              | 1             |
| Mecoprop         | mg/l     | min   |                 |    |              | 0.04          |
|                  |          | max   |                 |    |              | 0.04          |
|                  |          | mean  |                 |    |              | 0.04          |
|                  |          | count |                 |    |              | 1             |
| Suspended Solids | mg/l     | min   | 5               | 5  | 6            |               |
|                  |          | max   | 8               | 5  | 16           |               |
|                  |          | mean  | 6.5             | 5  | 9.33         |               |
|                  |          | count | 2               | 1  | 3            |               |
| pH               | pH units | min   | 7.7             | 7  | 7.6          |               |
|                  |          | max   | 7.7             | 7  | 7.7          |               |
|                  |          | mean  | 7.7             | 7  | 7.633        |               |
|                  |          | count | 2               | 1  | 3            |               |

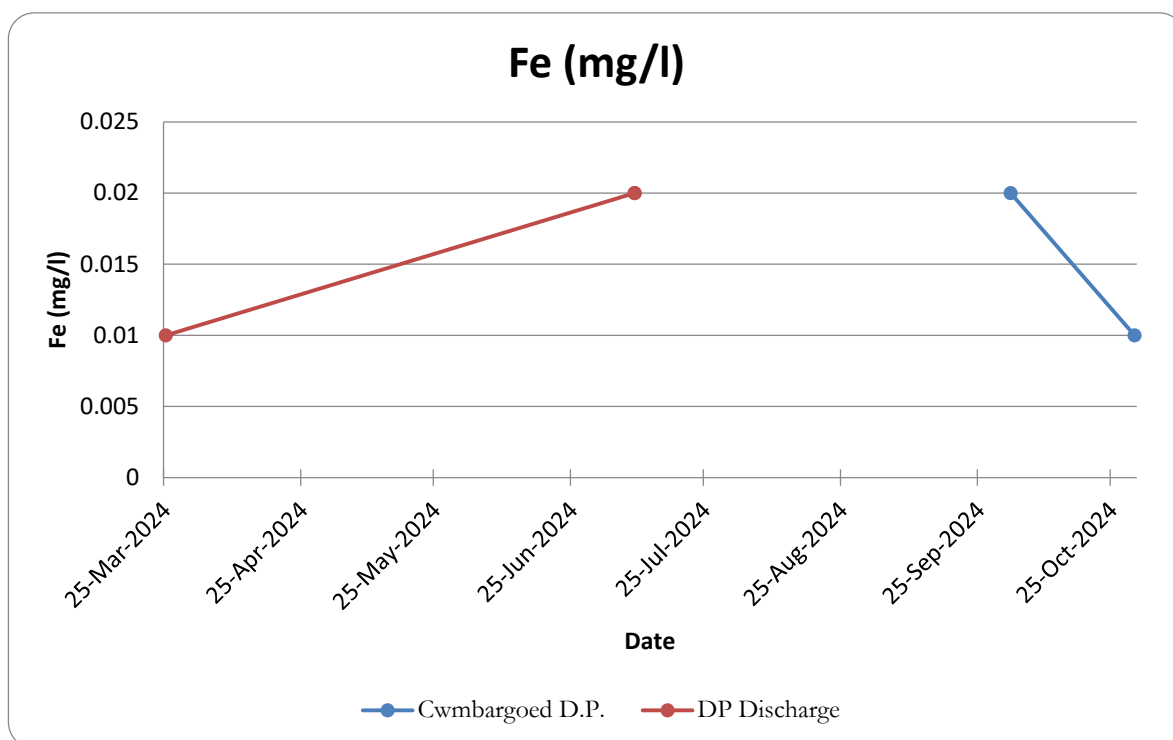


Figure 76: Fe Concentration timeseries within the Dowlais Fault

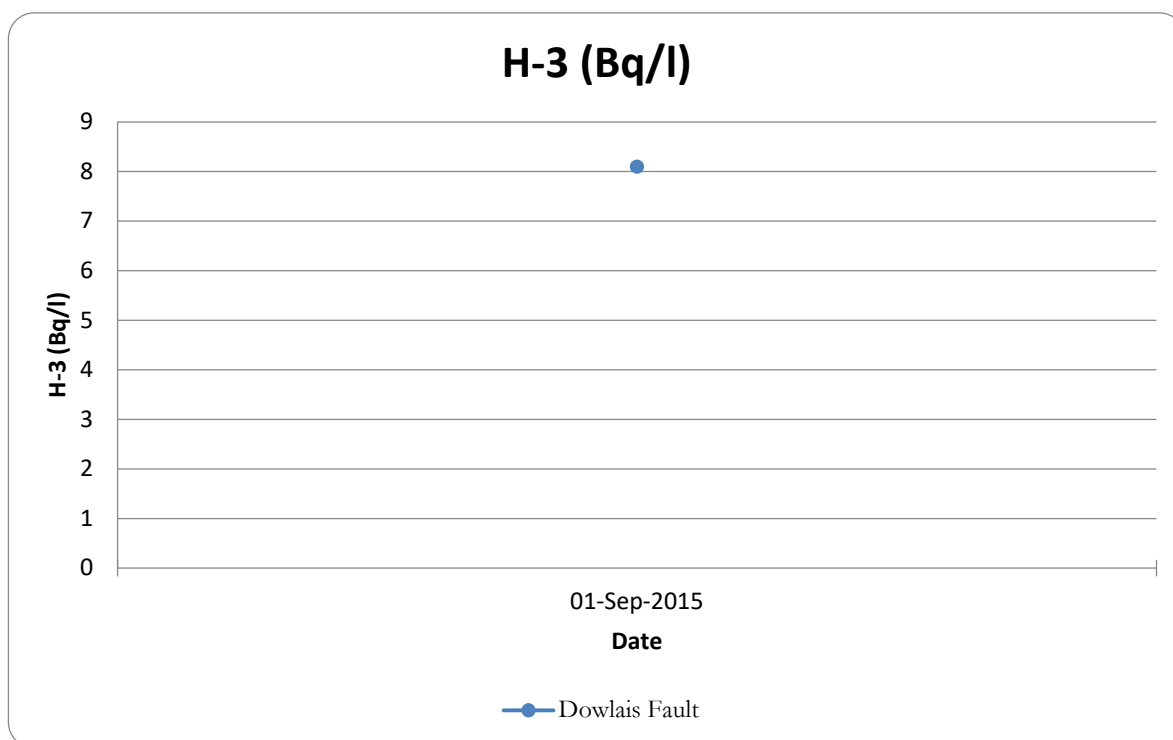


Figure 77: Tritium Concentration timeseries within the Dowlais Fault

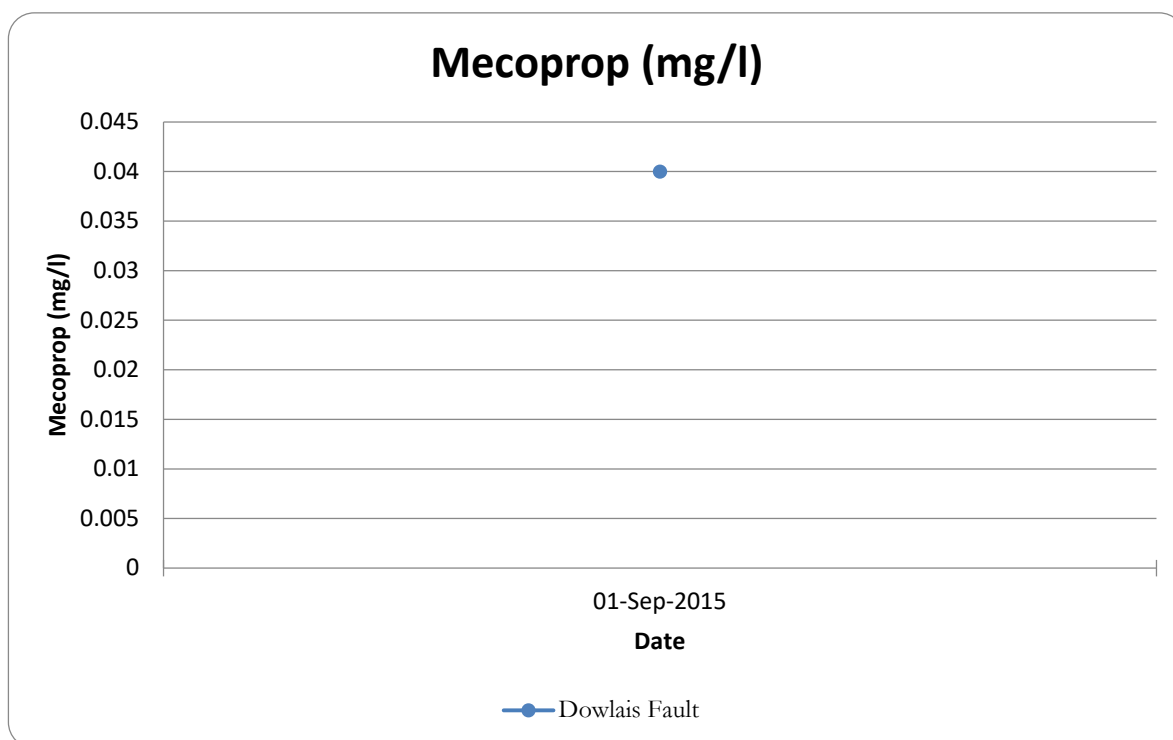


Figure 78: Mecoprop Concentration timeseries within the Dowlais Fault

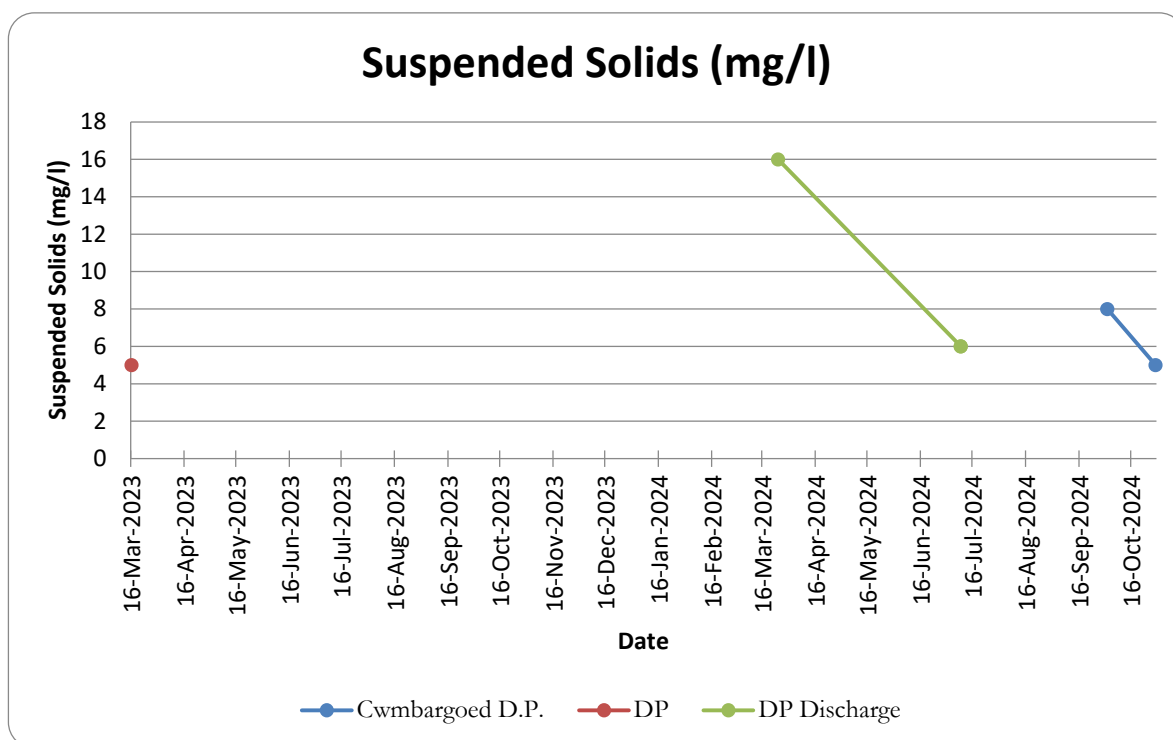


Figure 79: Suspended Solids Concentration timeseries within the Dowlais Fault

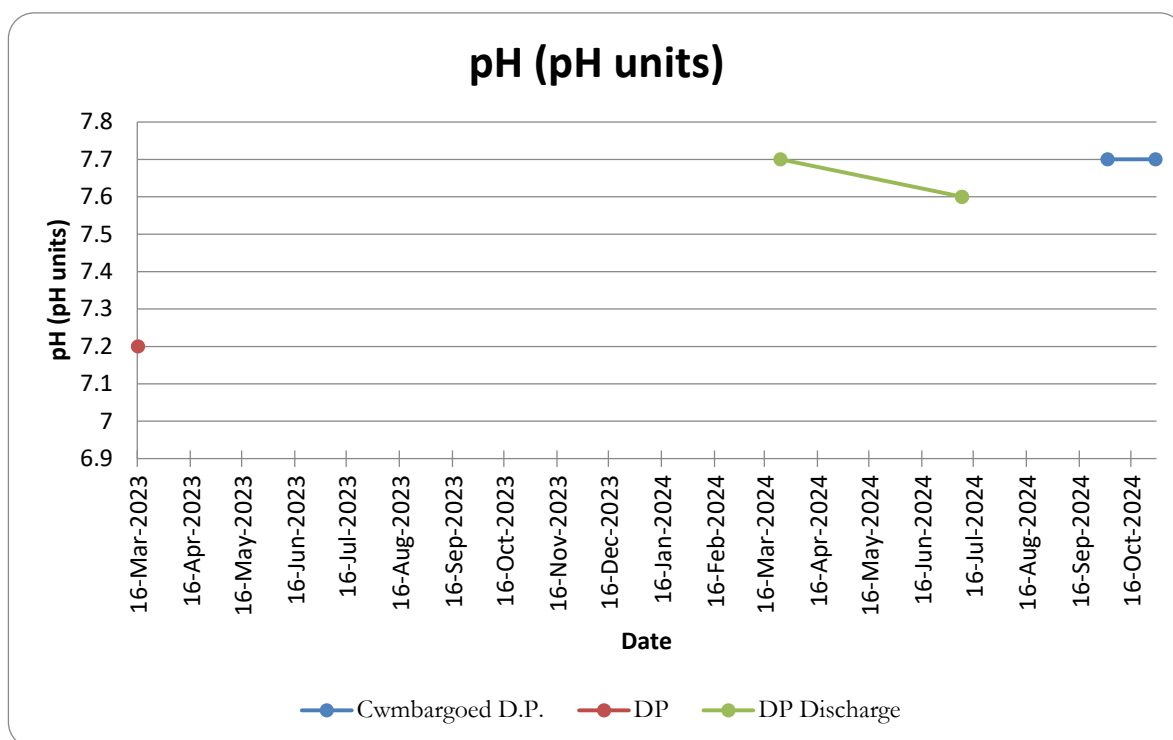


Figure 80: pH Concentration timeseries within the Dowlais Fault

## 6 DISCHARGE

Table 6 Discharge Monitoring Point Statistics

| Parameter        | Units    | Stat  | WB   | WC01   | WI     |
|------------------|----------|-------|------|--------|--------|
| Fe               | mg/l     | min   | 0.01 | 0      | 0      |
|                  |          | max   | 0.01 | 0.01   | 0.01   |
|                  |          | mean  | 0.01 | 0.0086 | 0.0086 |
|                  |          | count | 3    | 7      | 7      |
| H-3              | Bq/l     | min   | 5    |        |        |
|                  |          | max   | 5    |        |        |
|                  |          | mean  | 5    |        |        |
|                  |          | count | 2    |        |        |
| Mecoprop         | mg/l     | min   | 0.04 |        |        |
|                  |          | max   | 0.04 |        |        |
|                  |          | mean  | 0.04 |        |        |
|                  |          | count | 2    |        |        |
| Suspended Solids | mg/l     | min   | 5    | 5      | 5      |
|                  |          | max   | 10   | 37     | 20     |
|                  |          | mean  | 6.5  | 10.7   | 8.8    |
|                  |          | count | 6    | 10     | 10     |
| pH               | pH units | min   | 7.5  | 7.4    | 7.7    |
|                  |          | max   | 8.3  | 8.2    | 8.4    |
|                  |          | mean  | 7.86 | 8.09   | 8.25   |
|                  |          | count | 5    | 10     | 10     |

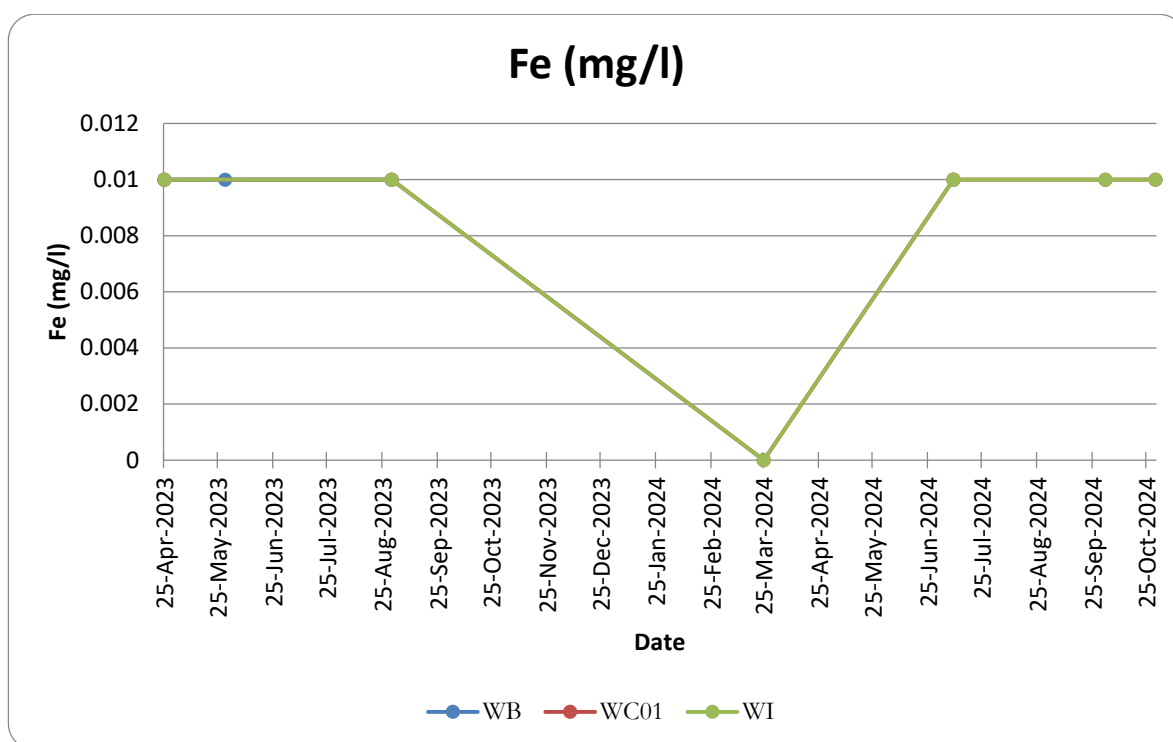


Figure 81: Fe Concentration timeseries within the Discharge

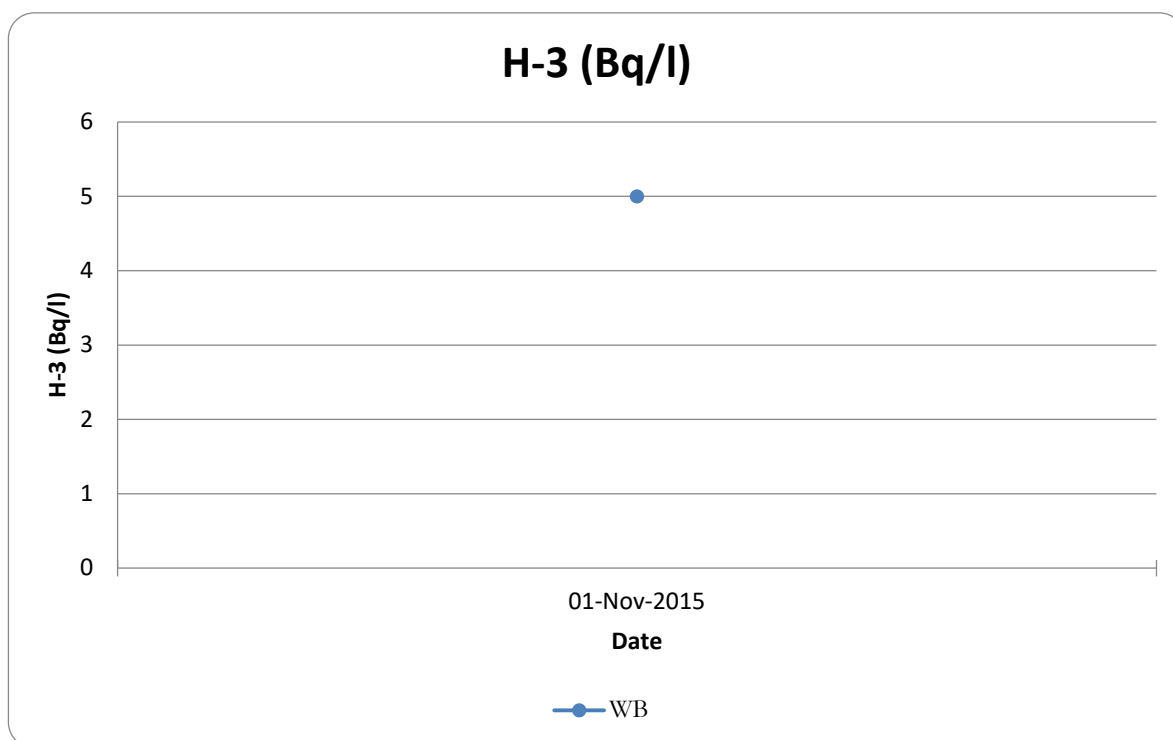


Figure 82: Tritium Concentration timeseries within the Discharge

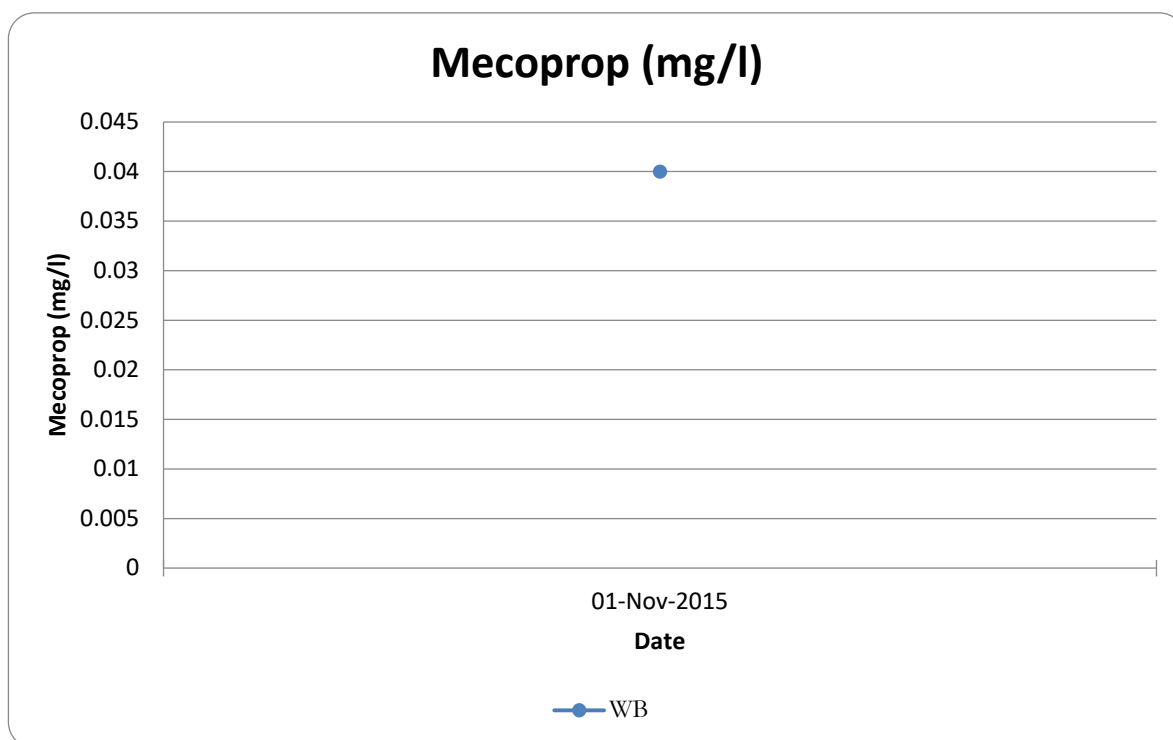


Figure 83: Mecoprop Concentration timeseries within the Discharge

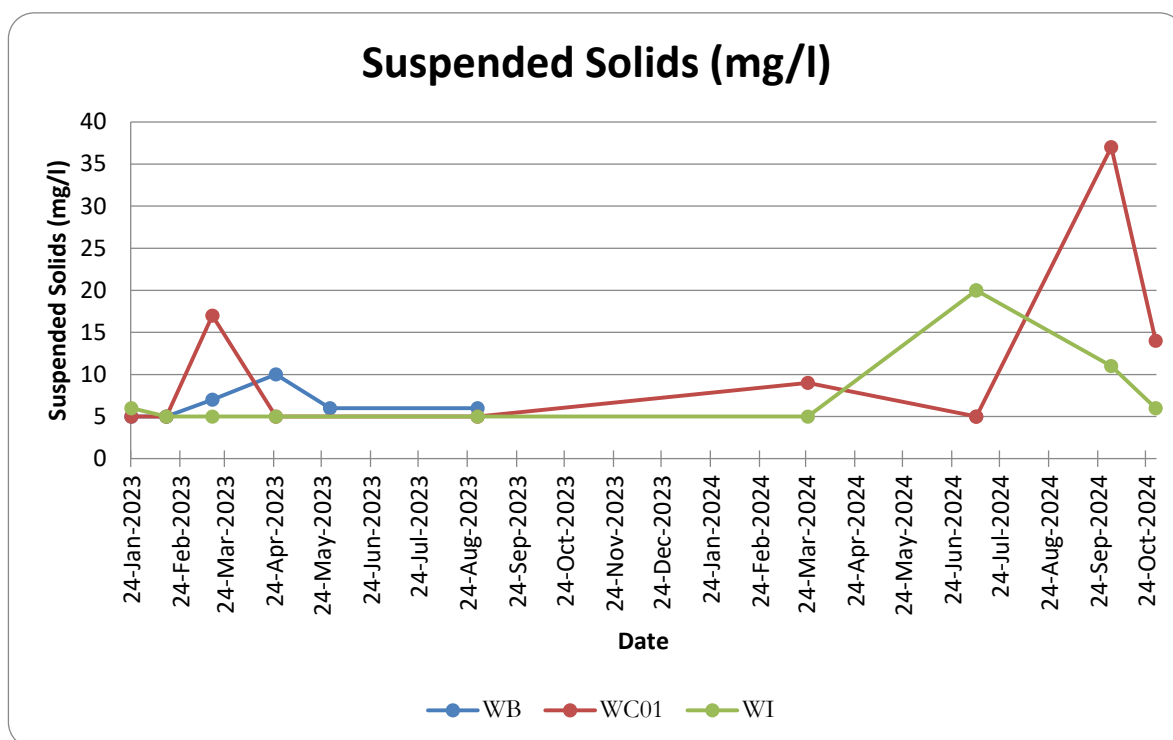


Figure 84: Suspended Solids Concentration timeseries within the Discharge

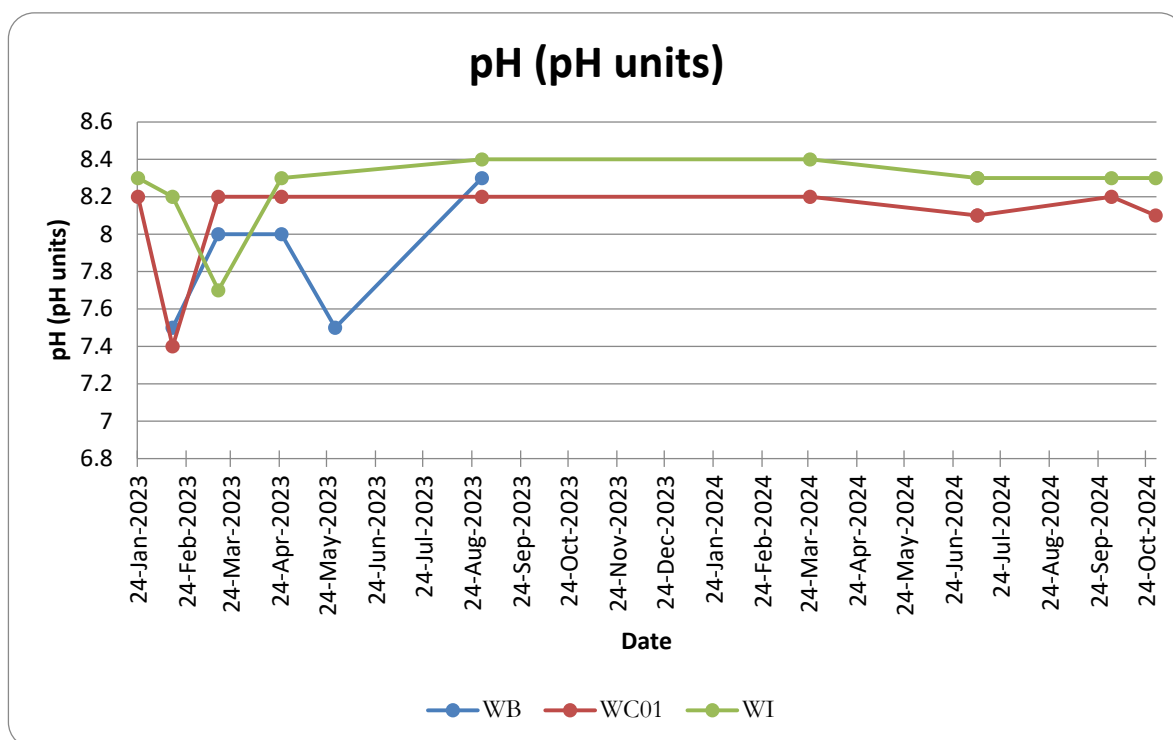


Figure 85: pH Concentration timeseries within the Discharge

## 7 DISCHARGE POINT

Table 7 Discharge Point Monitoring Point Statistics

| Parameter    | Units | Stat  | MA05    |
|--------------|-------|-------|---------|
| Al           | mg/l  | min   | 0.01    |
|              |       | max   | 4.53    |
|              |       | mean  | 0.2139  |
|              |       | count | 75      |
| Alkalinity   | mg/l  | min   | 86      |
|              |       | max   | 403     |
|              |       | mean  | 199.116 |
|              |       | count | 69      |
| As           | mg/l  | min   | 0.0005  |
|              |       | max   | 0.01    |
|              |       | mean  | 0.0016  |
|              |       | count | 53      |
| Ca           | mg/l  | min   | 29.1    |
|              |       | max   | 201     |
|              |       | mean  | 66.777  |
|              |       | count | 77      |
| Cd           | mg/l  | min   | 0       |
|              |       | max   | 0.002   |
|              |       | mean  | 0.00032 |
|              |       | count | 54      |
| Cl           | mg/l  | min   | 3       |
|              |       | max   | 39      |
|              |       | mean  | 7.19    |
|              |       | count | 76      |
| Conductivity | mS/cm | min   | 0.654   |
|              |       | max   | 1410    |
|              |       | mean  | 671.229 |
|              |       | count | 70      |
| Cr           | mg/l  | min   | 0.001   |
|              |       | max   | 0.01    |
|              |       | mean  | 0.0019  |
|              |       | count | 53      |
| Cu           | mg/l  | min   | 0       |
|              |       | max   | 0.01    |
|              |       | mean  | 0.0032  |
|              |       | count | 76      |
| Fe           | mg/l  | min   | 0       |
|              |       | max   | 2.63    |
|              |       | mean  | 0.229   |
|              |       | count | 76      |
| Hg           | mg/l  | min   | 0.00003 |
|              |       | max   | 0.001   |
|              |       | mean  | 0.00013 |
|              |       | count | 53      |
| K            | mg/l  | min   | 7       |
|              |       | max   | 72      |
|              |       | mean  | 32.93   |
|              |       | count | 77      |
| Mg           | mg/l  | min   | 11      |
|              |       | max   | 166     |
|              |       | mean  | 50.616  |
|              |       | count | 76      |



| Parameter        | Units    | Stat  | MA05    |
|------------------|----------|-------|---------|
| Mn               | mg/l     | min   | 0.002   |
|                  |          | max   | 0.511   |
|                  |          | mean  | 0.02827 |
|                  |          | count | 67      |
| Mo               | mg/l     | min   | 0.001   |
|                  |          | max   | 0.133   |
|                  |          | mean  | 0.00469 |
|                  |          | count | 51      |
| N                | mg/l     | min   | 0.01    |
|                  |          | max   | 5.56    |
|                  |          | mean  | 0.7966  |
|                  |          | count | 67      |
| NH3 (as N)       | mg/l     | min   | 0.01    |
|                  |          | max   | 0.3     |
|                  |          | mean  | 0.11    |
|                  |          | count | 77      |
| Na               | mg/l     | min   | 4       |
|                  |          | max   | 25      |
|                  |          | mean  | 9.78    |
|                  |          | count | 77      |
| Ni               | mg/l     | min   | 0       |
|                  |          | max   | 0.021   |
|                  |          | mean  | 0.00769 |
|                  |          | count | 54      |
| Pb               | mg/l     | min   | 0.0002  |
|                  |          | max   | 0.01    |
|                  |          | mean  | 0.0022  |
|                  |          | count | 76      |
| SO4              | mg/l     | min   | 44      |
|                  |          | max   | 873     |
|                  |          | mean  | 216.922 |
|                  |          | count | 77      |
| Se               | mg/l     | min   | 0       |
|                  |          | max   | 0.031   |
|                  |          | mean  | 0.00656 |
|                  |          | count | 70      |
| Suspended Solids | mg/l     | min   | 3       |
|                  |          | max   | 145     |
|                  |          | mean  | 18.084  |
|                  |          | count | 77      |
| Zn               | mg/l     | min   | 0       |
|                  |          | max   | 0.04    |
|                  |          | mean  | 0.014   |
|                  |          | count | 76      |
| pH               | pH units | min   | 7.5     |
|                  |          | max   | 8.8     |
|                  |          | mean  | 8.063   |
|                  |          | count | 78      |

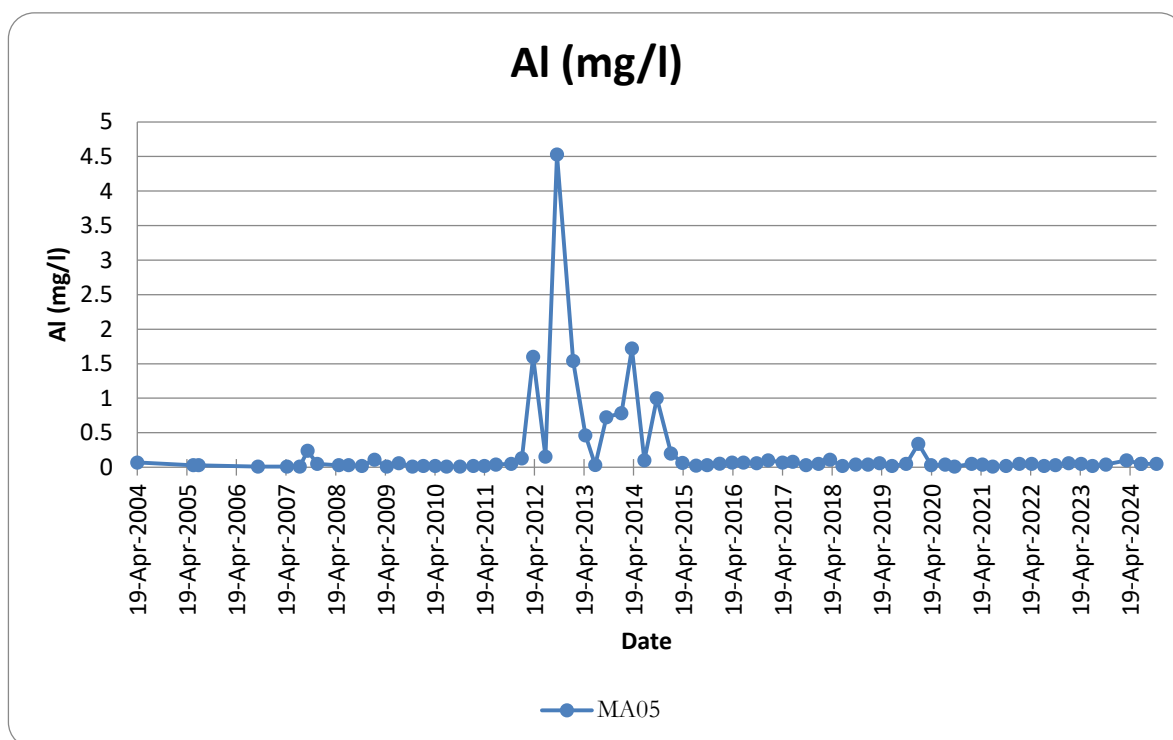


Figure 86: Al Concentration timeseries within the Discharge Point

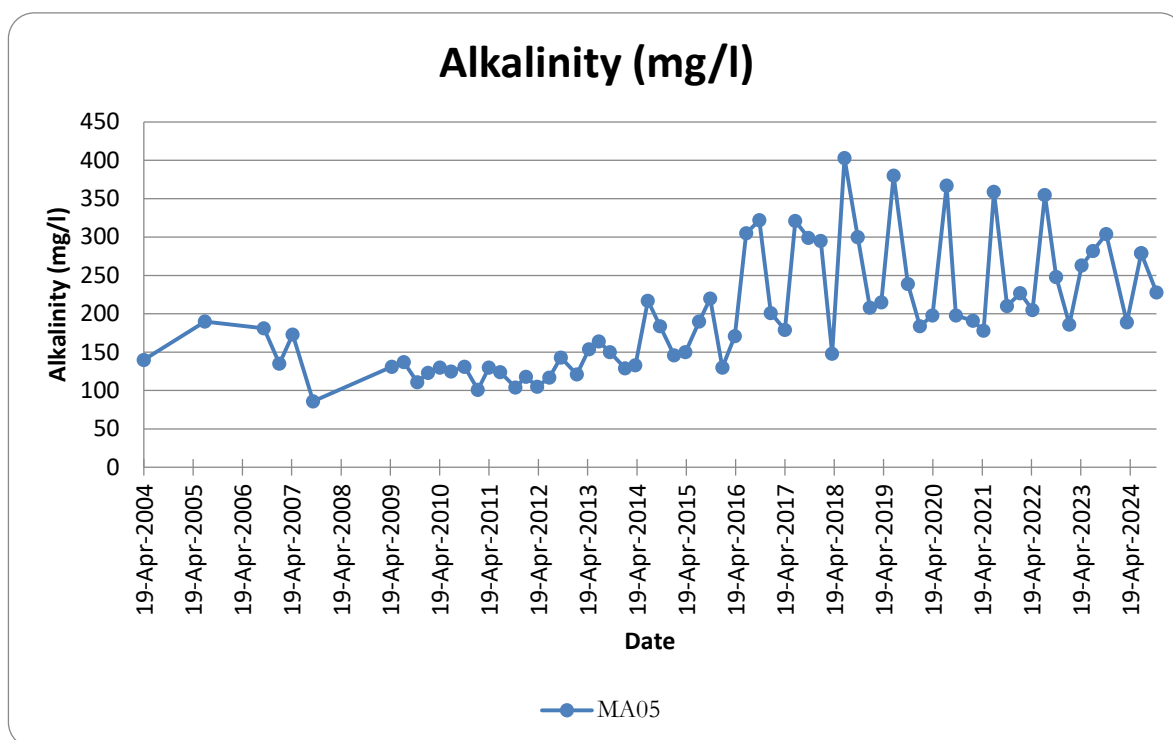


Figure 87: Alkalinity Concentration timeseries within the Discharge Point

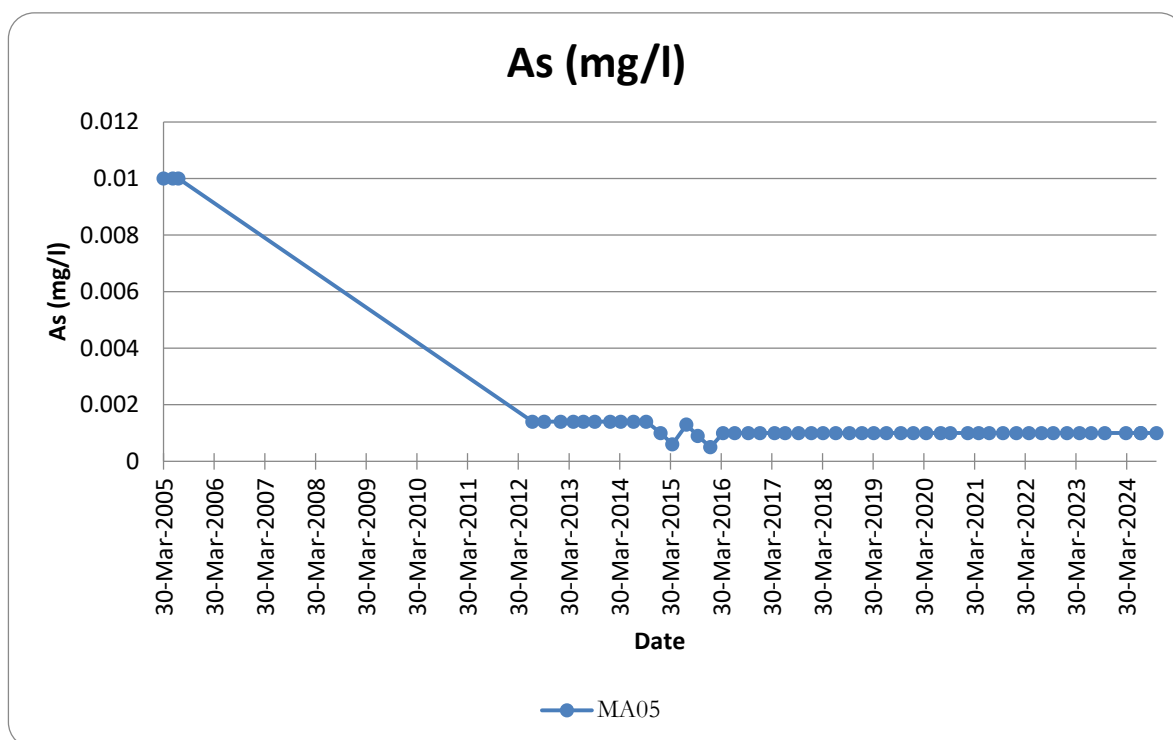


Figure 88: As Concentration timeseries within the Discharge Point

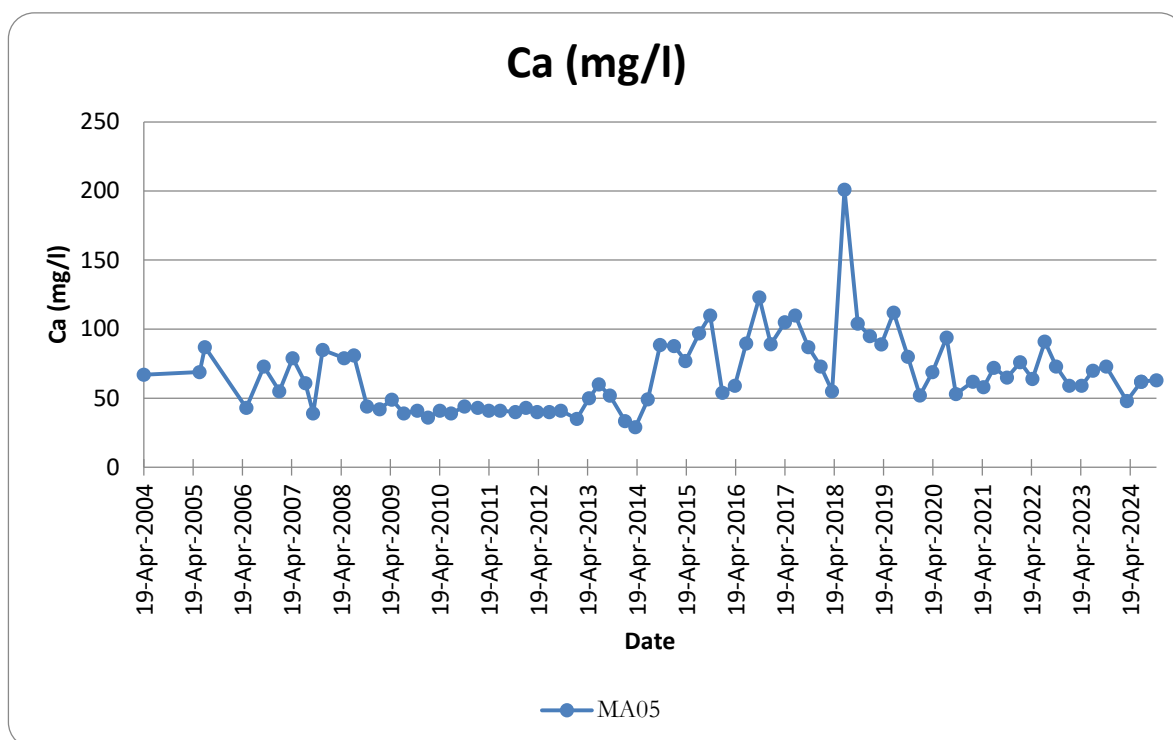


Figure 89: Ca Concentration timeseries within the Discharge Point

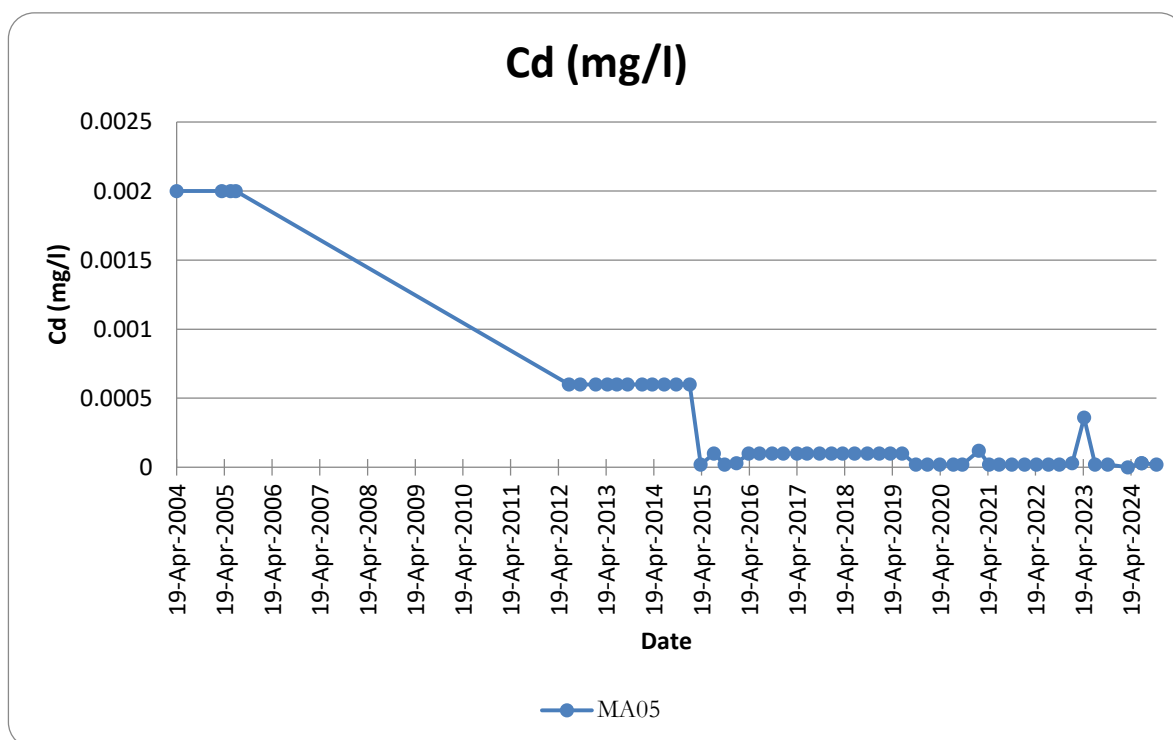


Figure 90: Cd Concentration timeseries within the Discharge Point

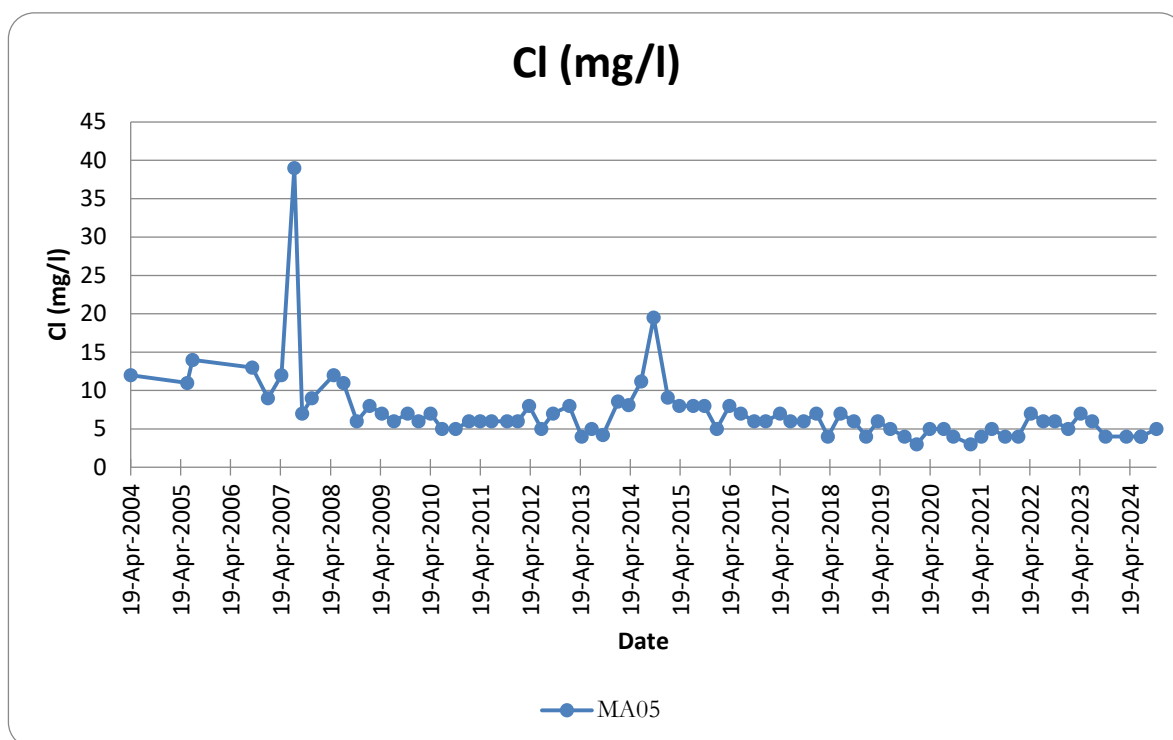


Figure 91: Cl Concentration timeseries within the Discharge Point

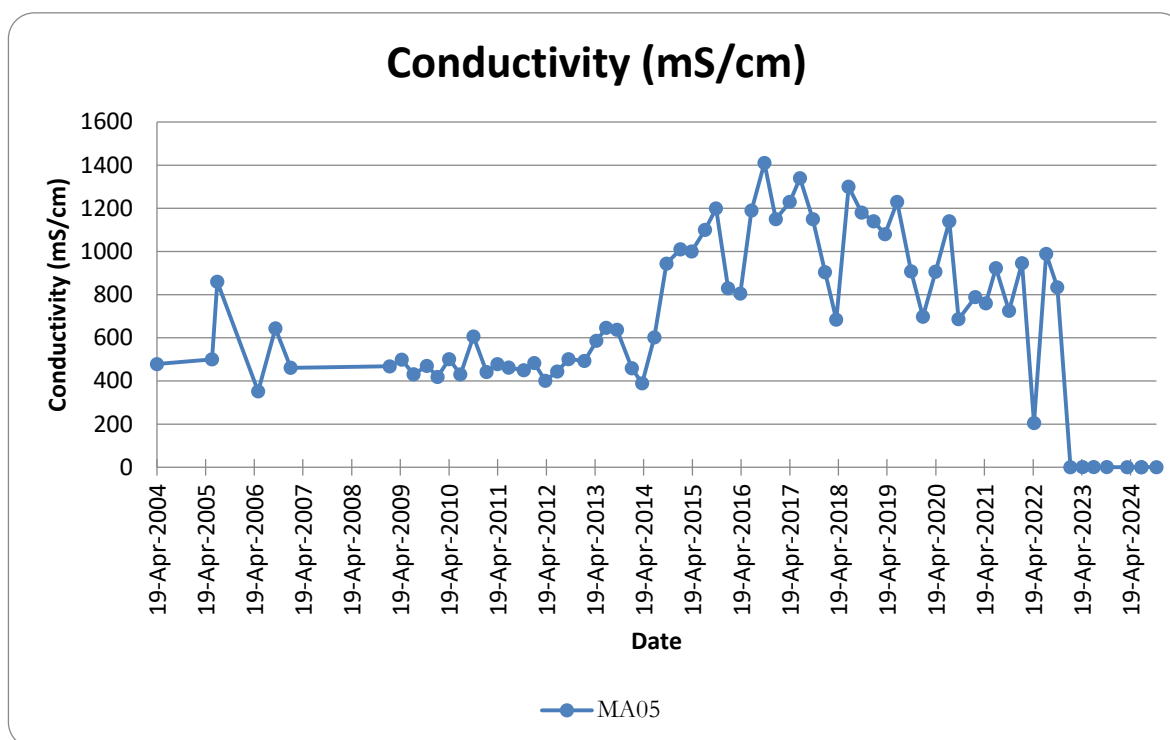


Figure 92: Electrical Conductivity timeseries within the Discharge Point

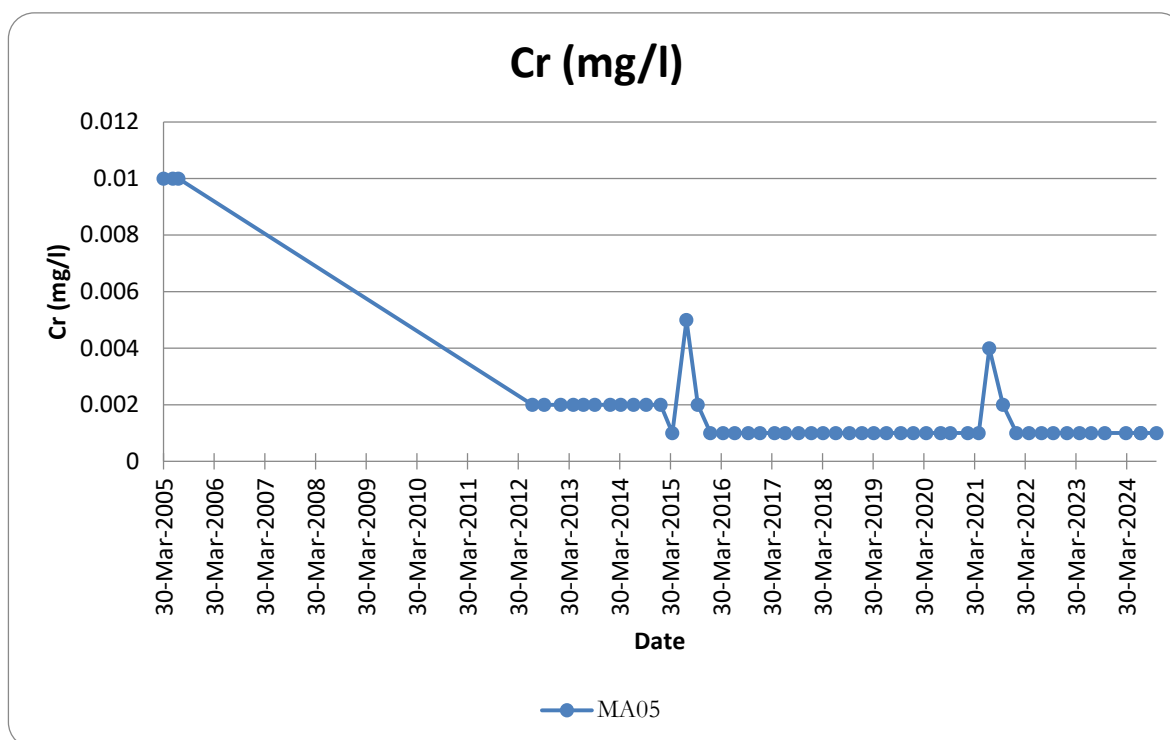


Figure 93:Cr Concentration timeseries within the Discharge Point

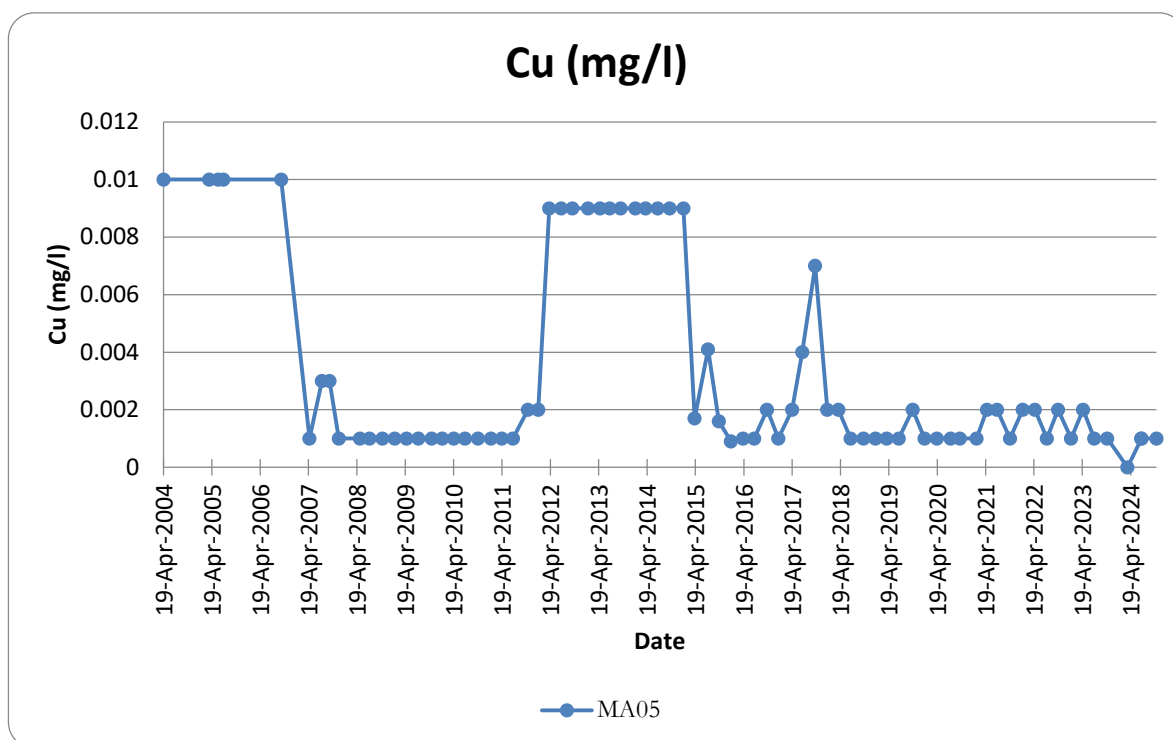


Figure 94: Cu Concentration timeseries within the Discharge Point

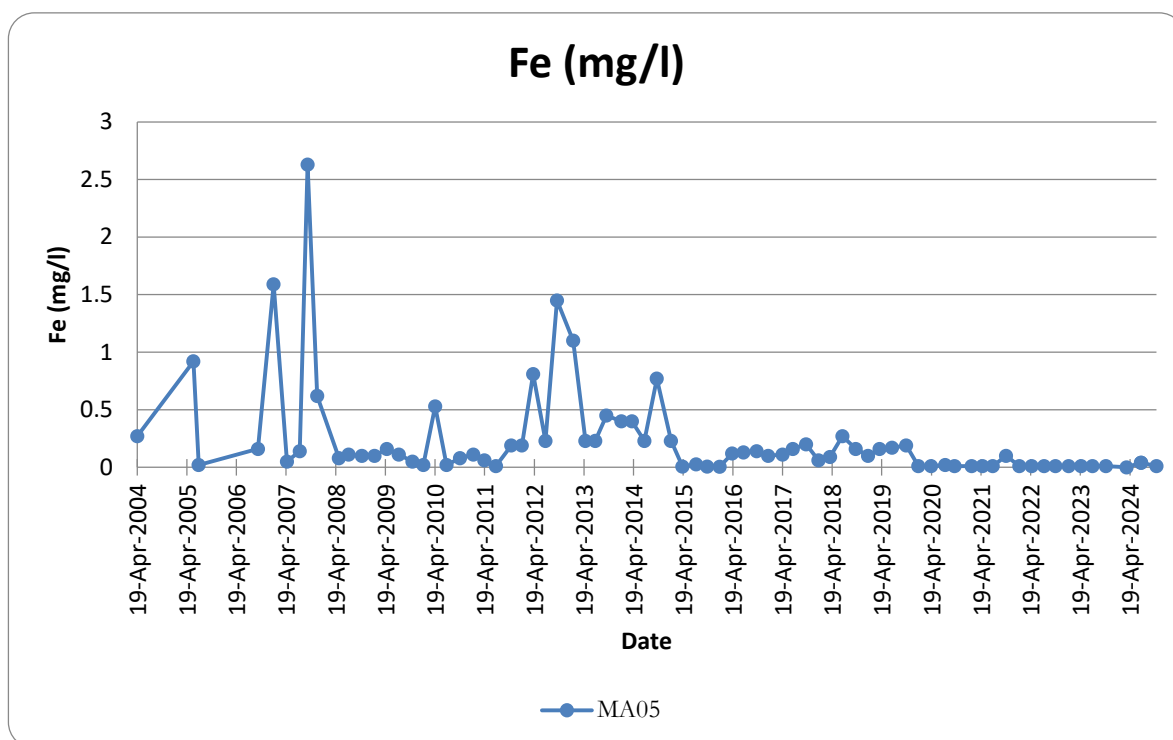


Figure 95: Fe Concentration timeseries within the Discharge Point

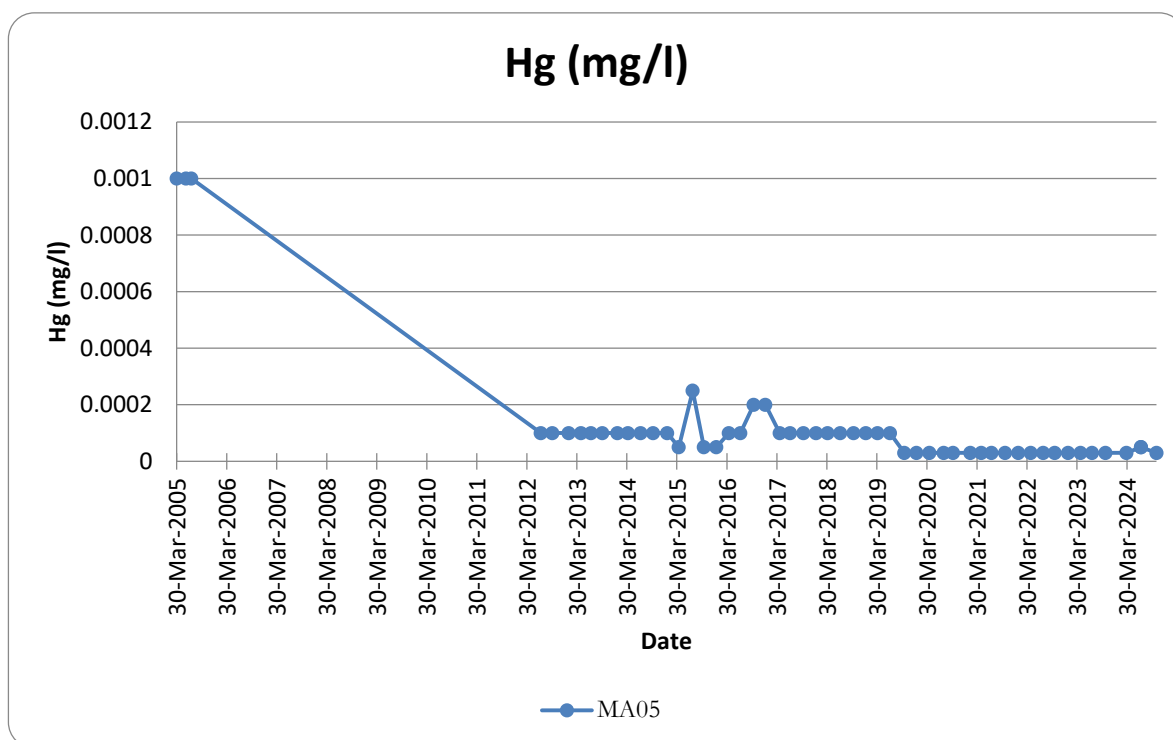


Figure 96: Hg Concentration timeseries within the Discharge Point

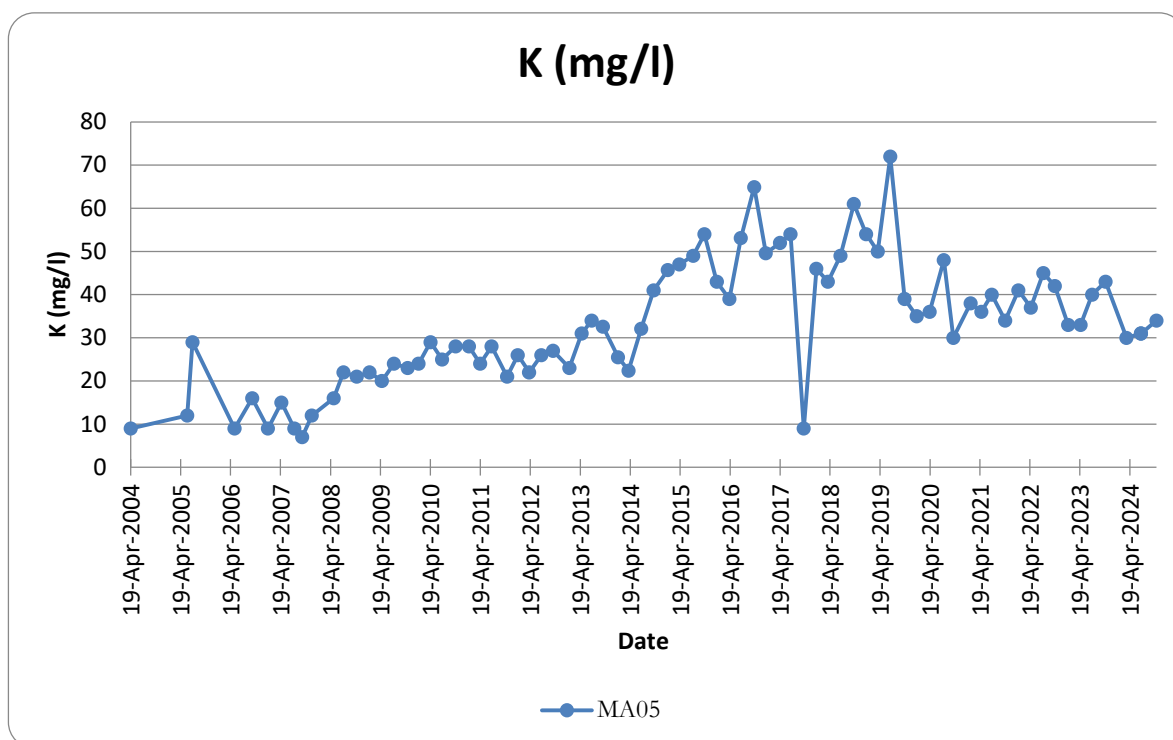


Figure 97: K Concentration timeseries within the Discharge Point

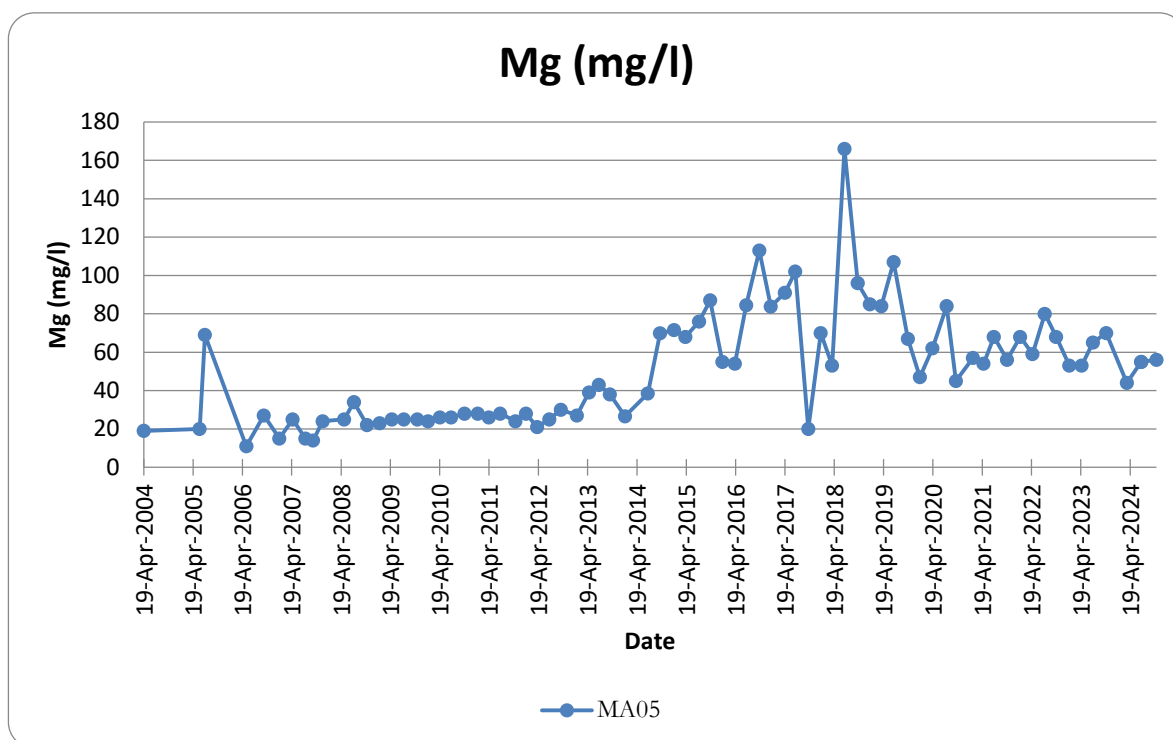


Figure 98: Mg Concentration timeseries within the Discharge Point

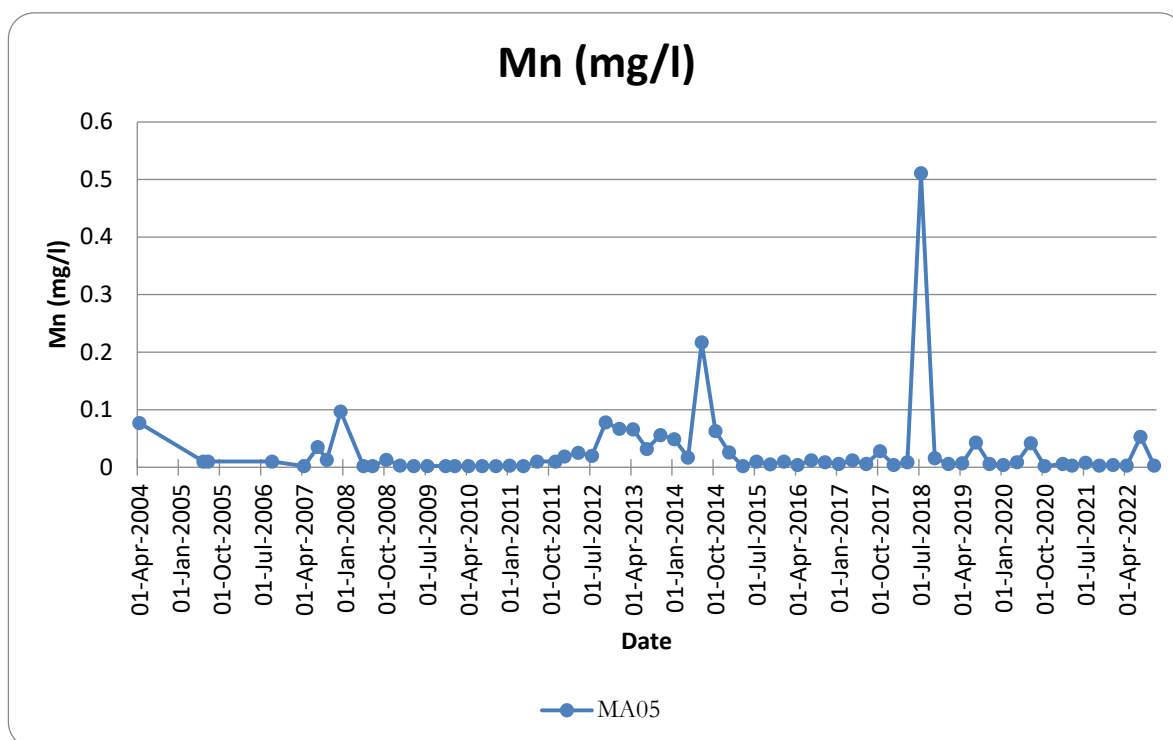


Figure 99: Mn Concentration timeseries within the Discharge Point

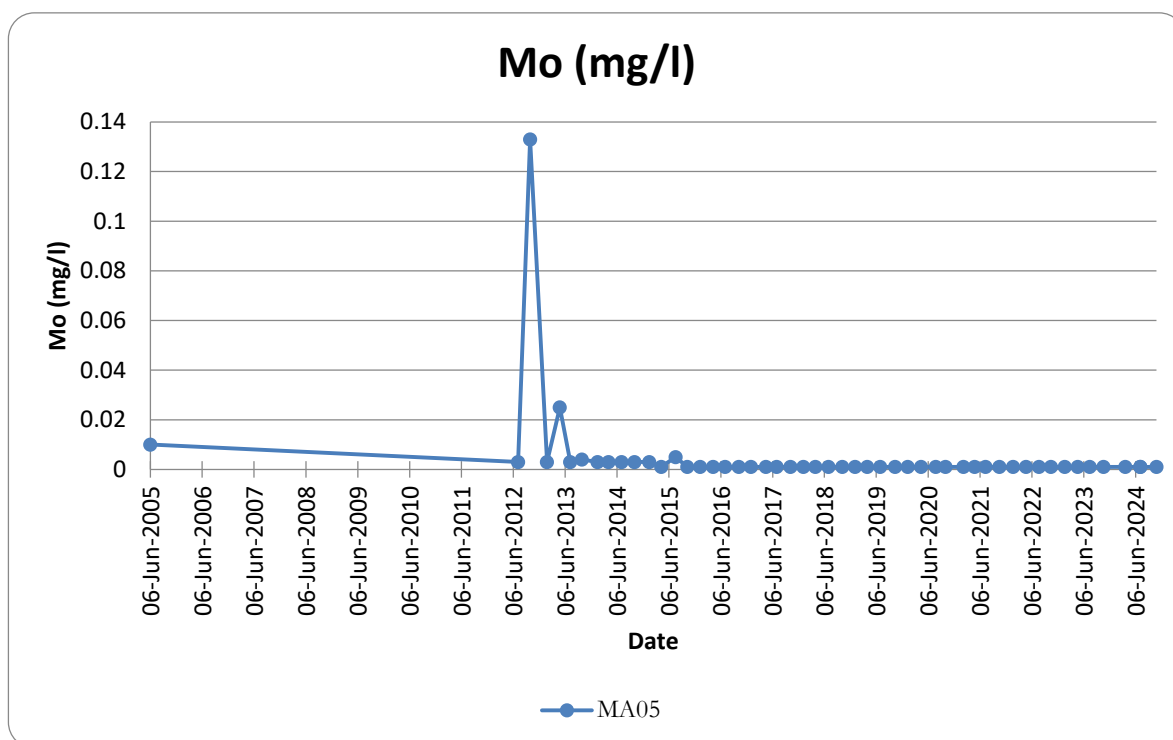


Figure 100: Mo Concentration timeseries within the Discharge Point

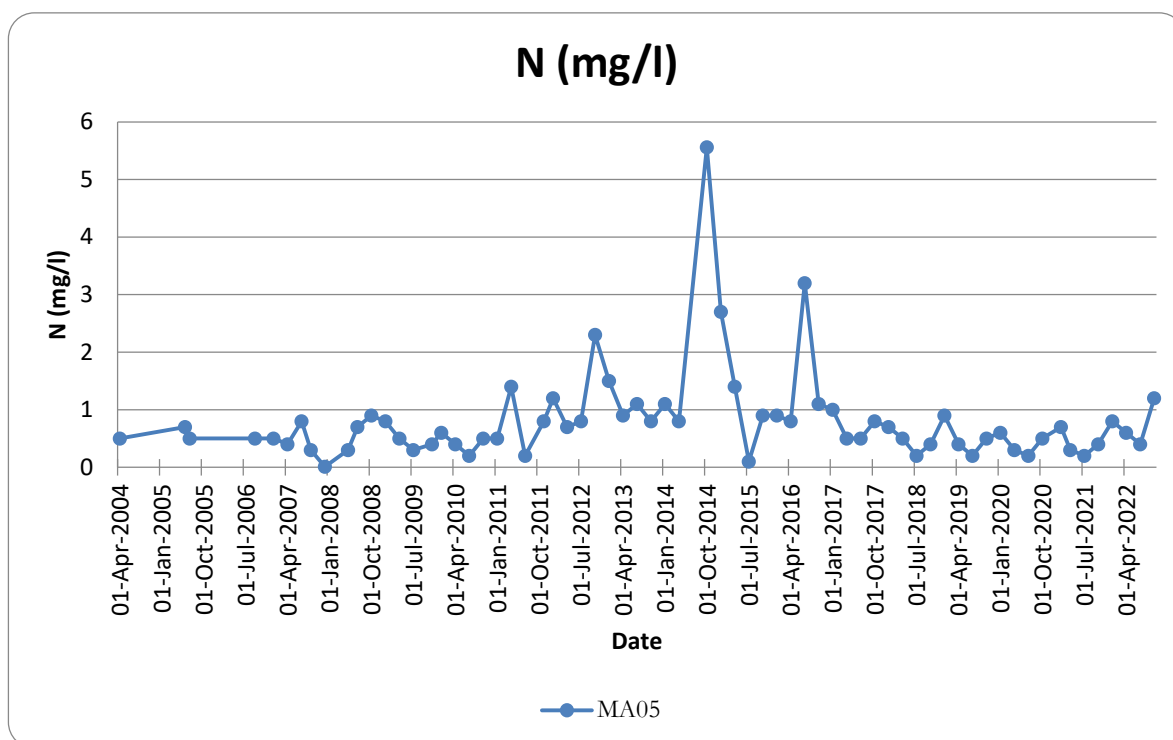


Figure 101: N Concentration timeseries within the Discharge Point

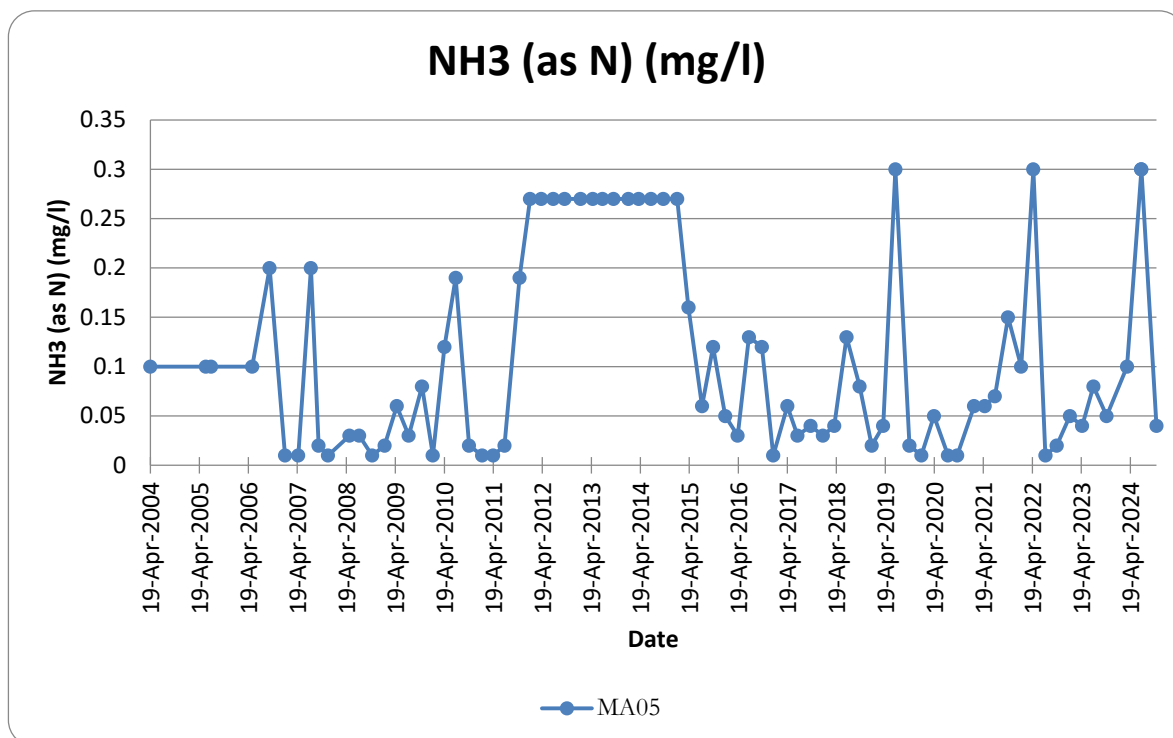


Figure 102: NH3 (as N) Concentration timeseries within the Discharge Point

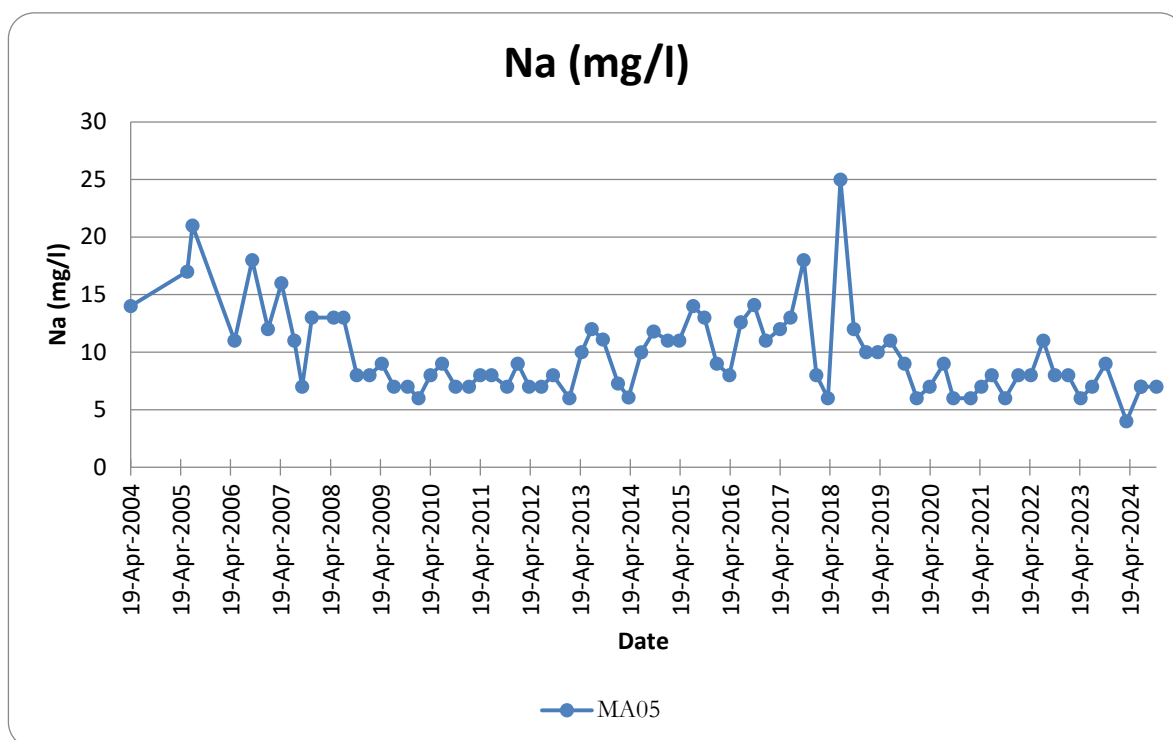


Figure 103: Na Concentration timeseries within the Discharge Point

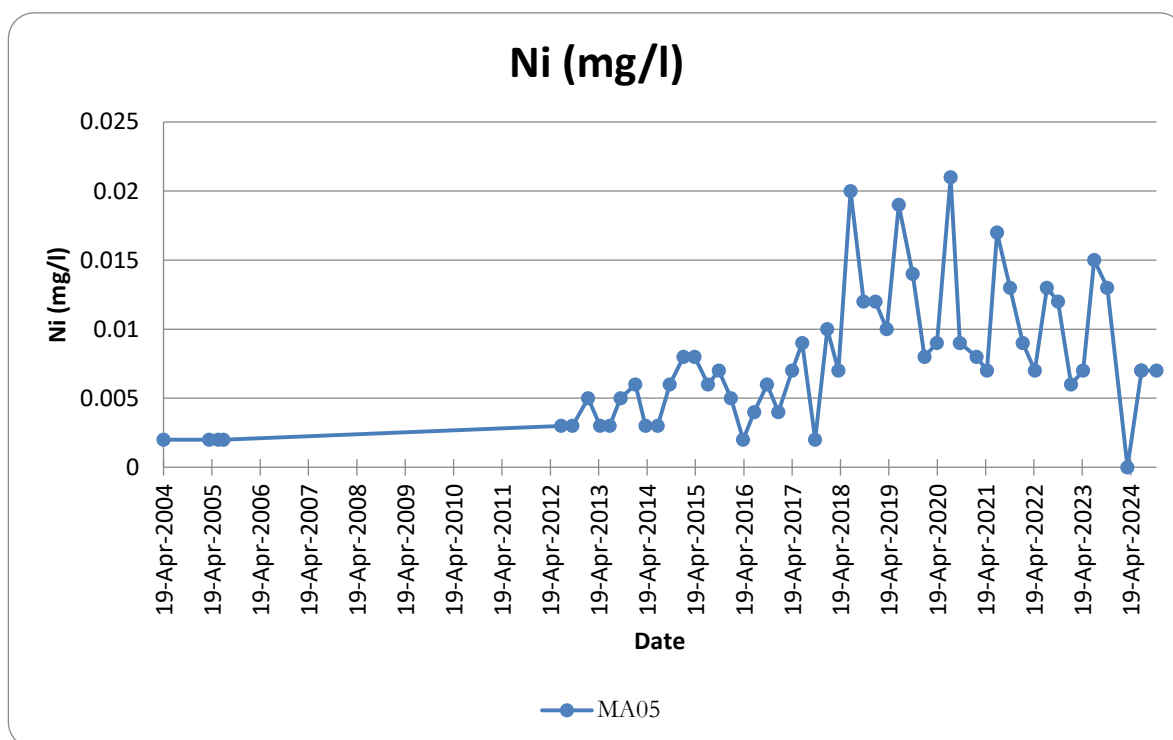


Figure 104: Ni Concentration timeseries within the Discharge Point

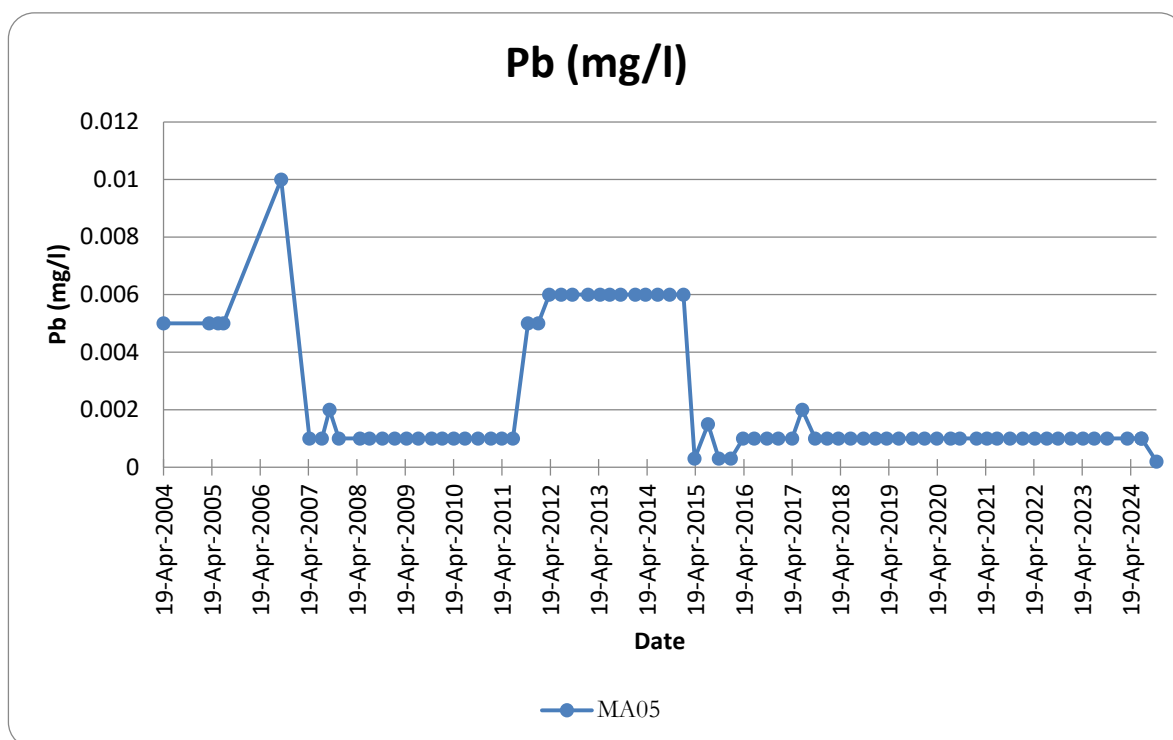


Figure 105: Pb Concentration timeseries within the Discharge Point

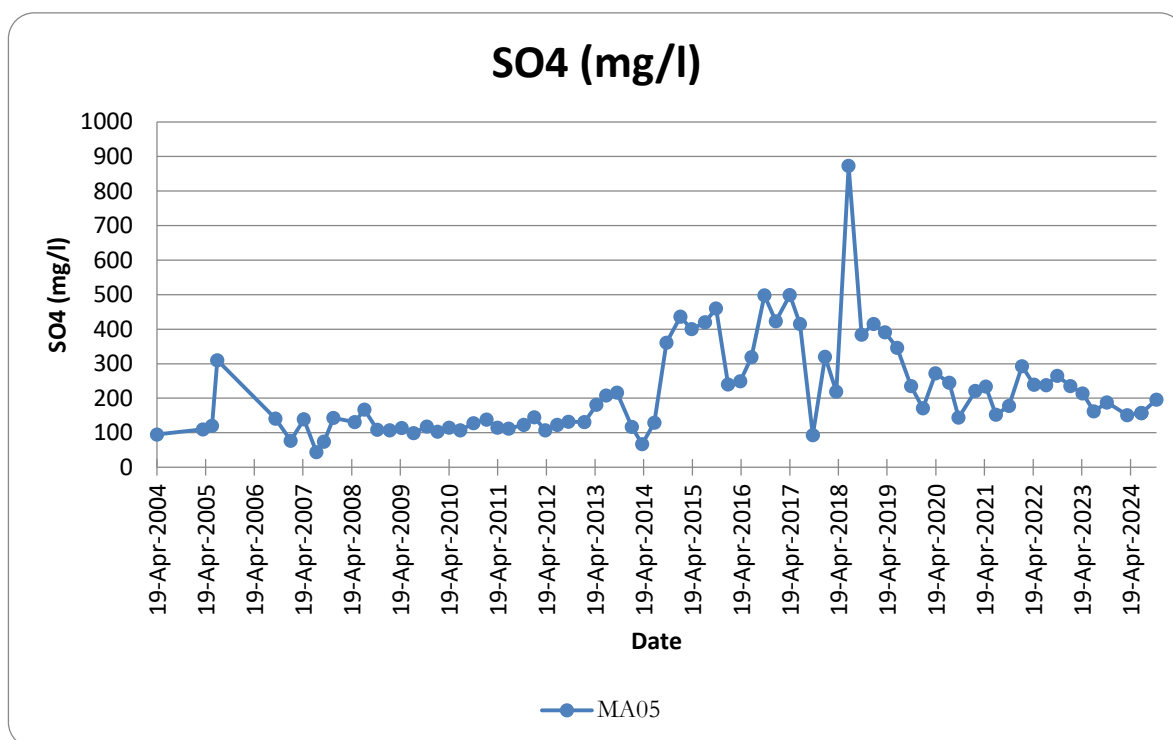


Figure 106: SO<sub>4</sub> Concentration timeseries within the Discharge Point

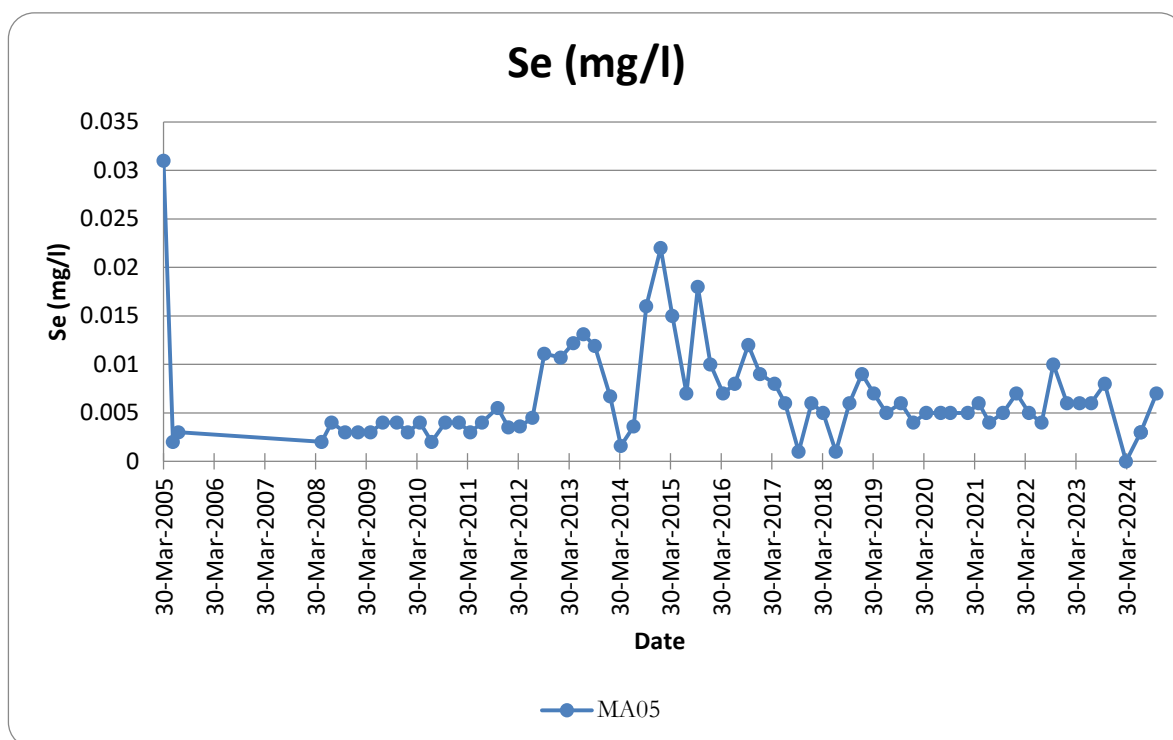


Figure 107: Se Concentration timeseries within the Discharge Point

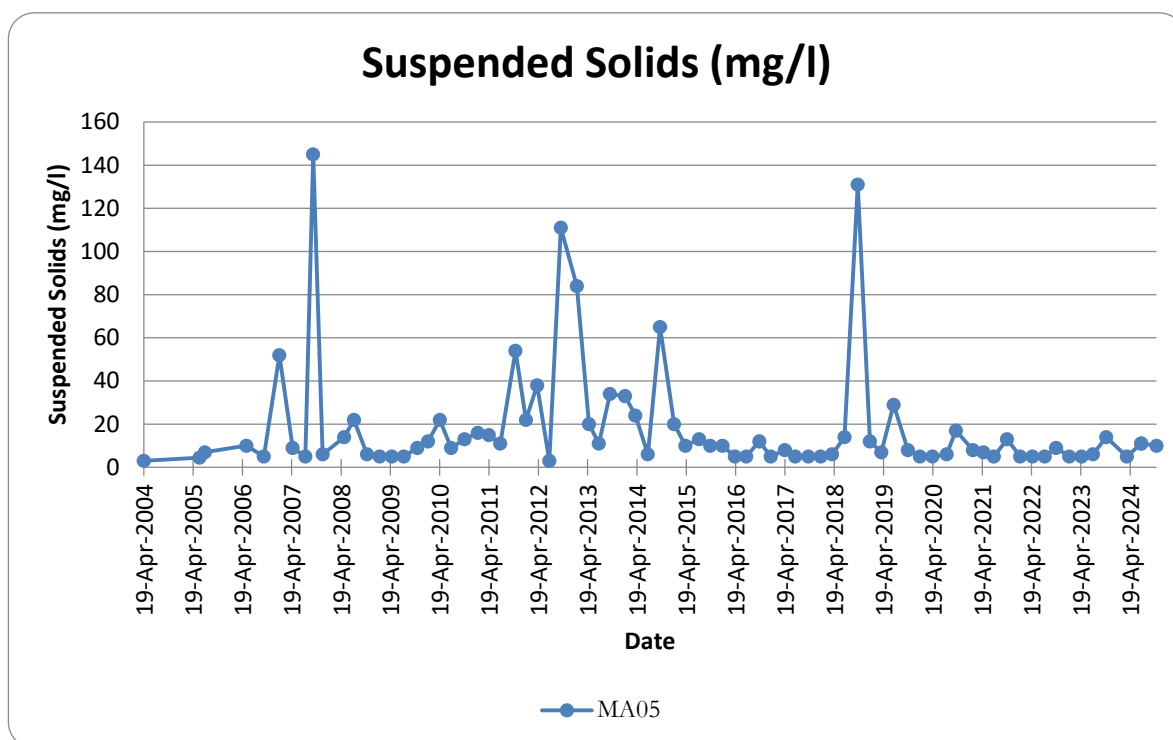


Figure 108: Suspended Solids Concentration timeseries within the Discharge Point

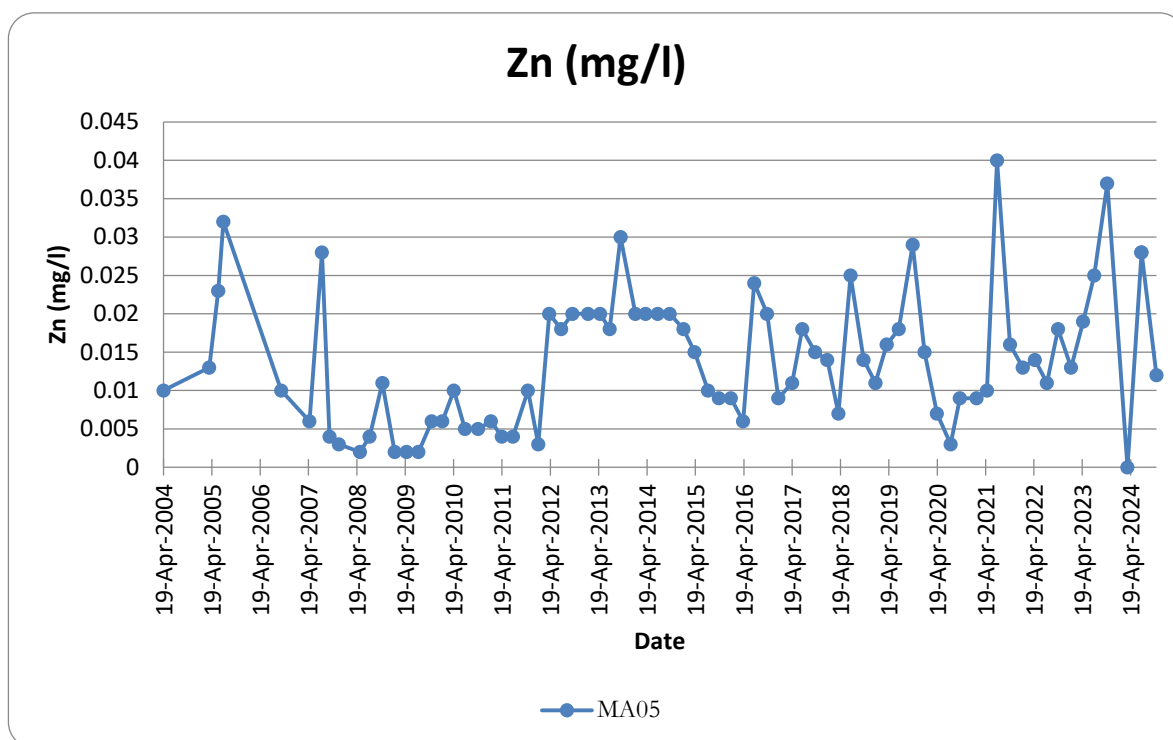


Figure 109: Zn Concentration timeseries within the Discharge Point

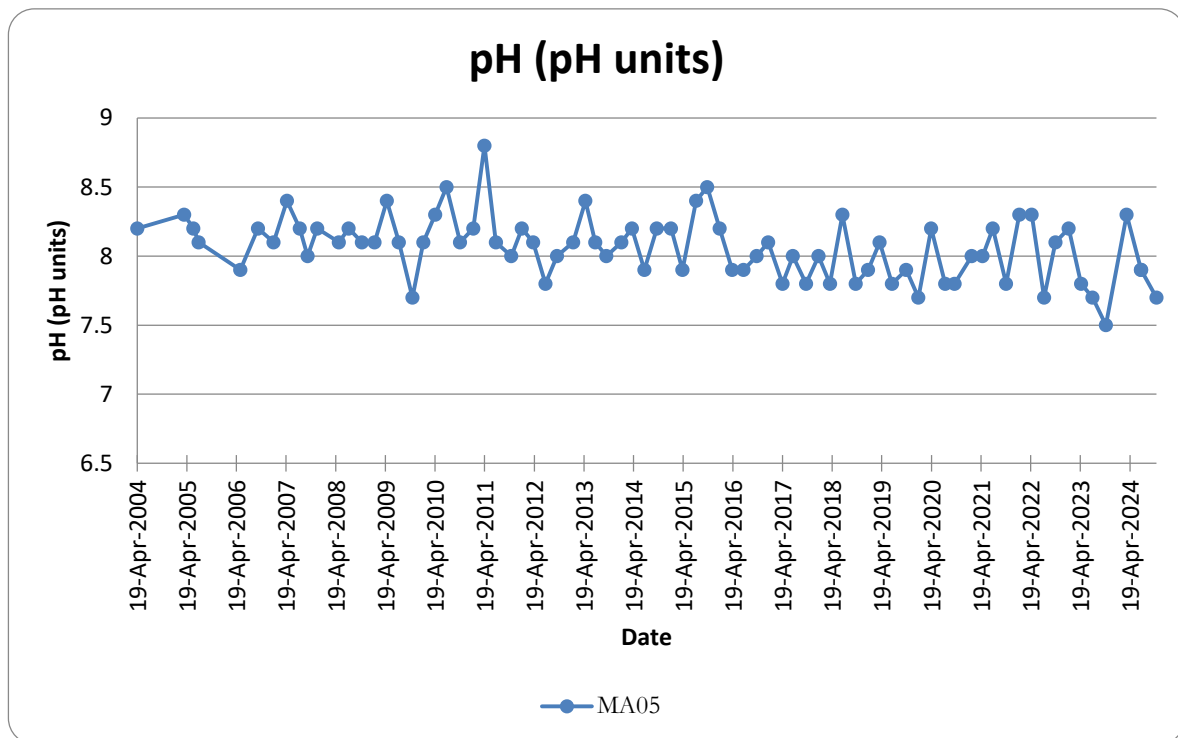


Figure 110: pH Concentration timeseries within the Discharge Point

## 8 TRECATTI GROUNDWATER (GW – BIFFA)

Table 8 Trecatti Groundwater Monitoring Point Statistics

| Parameter    | Units | Stat  | GW01     | GW02     | GW12     | GW4      | GW6      | GW8      |
|--------------|-------|-------|----------|----------|----------|----------|----------|----------|
| Alkalinity   | mg/l  | min   | 323      | 789      | 441      | 597      | 491      | 398      |
|              |       | max   | 440      | 850      | 722      | 738      | 616      | 564      |
|              |       | mean  | 384.4    | 815.4    | 633.8    | 662.2    | 537.3    | 512      |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| As           | mg/l  | min   | 0.00024  | 0.00024  | 0.00042  | 0.00024  | 0.00024  | 0.00024  |
|              |       | max   | 0.00024  | 0.00024  | 0.00085  | 0.00035  | 0.00024  | 0.00024  |
|              |       | mean  | 0.00024  | 0.00024  | 0.000693 | 0.000277 | 0.00024  | 0.00024  |
|              |       | count | 3        | 3        | 3        | 3        | 3        | 3        |
| Ca           | mg/l  | min   | 42.9     | 110      | 7.26     | 200      | 37.9     | 190      |
|              |       | max   | 99       | 130      | 180      | 240      | 210      | 270      |
|              |       | mean  | 56.33    | 113      | 148.726  | 214      | 160.79   | 218      |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| Cd           | mg/l  | min   | 0.00007  | 0.00007  | 0.00007  | 0.00007  | 0.00007  | 0.00007  |
|              |       | max   | 0.00007  | 0.00007  | 0.0007   | 0.00007  | 0.00007  | 0.00008  |
|              |       | mean  | 0.00007  | 0.00007  | 0.000133 | 0.00007  | 0.00007  | 0.000071 |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| Cl           | mg/l  | min   | 6.8      | 231      | 43.8     | 16       | 166      | 527      |
|              |       | max   | 12.7     | 350      | 61.1     | 277      | 477      | 882      |
|              |       | mean  | 9.84     | 258.7    | 51.78    | 68.35    | 255.4    | 719      |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| Conductivity | mS/cm | min   | 0.553    | 1.9      | 1.13     | 1.82     | 1.66     | 2.71     |
|              |       | max   | 0.862    | 2.1      | 1.89     | 2.26     | 2.58     | 3.46     |
|              |       | mean  | 0.6527   | 1.977    | 1.688    | 2.001    | 1.992    | 3.095    |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| Cr           | mg/l  | min   | 0.00051  | 0.0011   | 0.00051  | 0.00051  | 0.00051  | 0.00051  |
|              |       | max   | 0.00051  | 0.0019   | 0.00051  | 0.00051  | 0.00072  | 0.00053  |
|              |       | mean  | 0.00051  | 0.00143  | 0.00051  | 0.00051  | 0.000531 | 0.000512 |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| Cu           | mg/l  | min   | 0.0018   | 0.0018   | 0.0018   | 0.0018   | 0.0018   | 0.0018   |
|              |       | max   | 0.0021   | 0.0053   | 0.0018   | 0.0022   | 0.0023   | 0.002    |
|              |       | mean  | 0.001823 | 0.002308 | 0.0018   | 0.001831 | 0.001862 | 0.001815 |
|              |       | count | 13       | 13       | 13       | 13       | 13       | 13       |
| Fe           | mg/l  | min   | 0.025    | 0.025    | 0.025    | 0.025    | 0.025    | 0.025    |
|              |       | max   | 0.388    | 1.1      | 0.25     | 1.8      | 0.566    | 0.776    |
|              |       | mean  | 0.062    | 0.3297   | 0.0722   | 0.5644   | 0.2813   | 0.2418   |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| H-3          | Bq/l  | min   | 1.7      | 6        | 2        | 5        | 5        | 5        |
|              |       | max   | 141      | 268      | 17.8     | 11       | 11.1     | 7.1      |
|              |       | mean  | 6.313    | 129.8227 | 5.6338   | 5.68     | 6.87     | 5.21     |
|              |       | count | 46       | 44       | 34       | 10       | 10       | 10       |
| Hg           | mg/l  | min   | 0.00001  | 0.00001  | 0.00001  | 0.00001  | 0.00001  | 0.00001  |
|              |       | max   | 0.00001  | 0.00002  | 0.00001  | 0.00004  | 0.00003  | 0.00001  |
|              |       | mean  | 0.00001  | 1.33E-05 | 0.00001  | 0.00002  | 1.67E-05 | 0.00001  |
|              |       | count | 3        | 3        | 3        | 3        | 3        | 3        |
| K            | mg/l  | min   | 23       | 116      | 76       | 74       | 56       | 58       |
|              |       | max   | 35       | 136      | 93       | 95       | 72       | 75       |
|              |       | mean  | 31.3     | 126.2    | 82.9     | 86.9     | 61.9     | 64.3     |
|              |       | count | 10       | 10       | 10       | 10       | 10       | 10       |
| Mecoprop     | mg/l  | min   | 0        | 0.00014  | 0.00004  | 0.00004  | 0.00004  | 0.00004  |
|              |       | max   | 0.05     | 0.87     | 0.04     | 0.0002   | 0.00008  | 0.00004  |
|              |       | mean  | 0.033063 | 0.459754 | 0.028247 | 0.00006  | 0.000045 | 0.00004  |
|              |       | count | 72       | 73       | 34       | 10       | 10       | 10       |

| Parameter  | Units    | Stat  | GW01   | GW02    | GW12    | GW4     | GW6     | GW8     |
|------------|----------|-------|--------|---------|---------|---------|---------|---------|
| Mg         | mg/l     | min   | 45     | 97      | 93      | 147     | 108     | 125     |
|            |          | max   | 60     | 121     | 172     | 185     | 146     | 171     |
|            |          | mean  | 54.6   | 106     | 146.1   | 167.5   | 120.1   | 141.2   |
|            |          | count | 10     | 10      | 10      | 10      | 10      | 10      |
| NH3 (as N) | mg/l     | min   | 0.06   | 13.2    | 0.41    | 0.74    | 1.92    | 0.06    |
|            |          | max   | 0.85   | 15.1    | 1.14    | 1.8     | 3.3     | 1.84    |
|            |          | mean  | 0.4409 | 14.2273 | 0.8018  | 1.3082  | 2.5591  | 0.4509  |
|            |          | count | 11     | 11      | 11      | 11      | 11      | 11      |
| Na         | mg/l     | min   | 6.8    | 112     | 30      | 18      | 72      | 190     |
|            |          | max   | 13     | 151     | 79      | 106     | 174     | 359     |
|            |          | mean  | 8.84   | 127.5   | 41.2    | 36.3    | 107     | 286.4   |
|            |          | count | 10     | 10      | 10      | 10      | 10      | 10      |
| Ni         | mg/l     | min   | 0.001  | 0.02    | 0.0011  | 0.0055  | 0.0068  | 0.0028  |
|            |          | max   | 0.001  | 0.026   | 0.0085  | 0.18    | 0.02    | 0.008   |
|            |          | mean  | 0.001  | 0.0221  | 0.00383 | 0.03454 | 0.01267 | 0.00435 |
|            |          | count | 10     | 10      | 10      | 10      | 10      | 10      |
| Pb         | mg/l     | min   | 0.0003 | 0.0003  | 0.0003  | 0.0003  | 0.0003  | 0.0003  |
|            |          | max   | 0.0003 | 0.0003  | 0.003   | 0.0003  | 0.0006  | 0.0014  |
|            |          | mean  | 0.0003 | 0.0003  | 0.00057 | 0.0003  | 0.00033 | 0.00041 |
|            |          | count | 10     | 10      | 10      | 10      | 10      | 10      |
| Zn         | mg/l     | min   | 0.047  | 2.4     | 0.024   | 0.009   | 0.006   | 0.006   |
|            |          | max   | 1.2    | 4.2     | 0.26    | 0.32    | 0.46    | 0.28    |
|            |          | mean  | 0.3083 | 3.37    | 0.0777  | 0.0823  | 0.0881  | 0.1033  |
|            |          | count | 10     | 10      | 10      | 10      | 10      | 10      |
| pH         | pH units | min   | 7.7    | 7       | 6.8     | 6.8     | 6.6     | 6.7     |
|            |          | max   | 8.5    | 8.2     | 9       | 8       | 8.1     | 8.2     |
|            |          | mean  | 8.09   | 7.34    | 7.41    | 7.32    | 7.06    | 7.21    |
|            |          | count | 10     | 10      | 10      | 10      | 10      | 10      |

Table 9 Trecatti Groundwater Monitoring Point Statistics (GW03, GW09 and GW10)

| Parameter | Units | Stat  | GW03     | GW09     | GW10     |
|-----------|-------|-------|----------|----------|----------|
| H-3       | Bq/l  | min   | 1.8      | 58.9     | 128      |
|           |       | max   | 5        | 227      | 288      |
|           |       | mean  | 2.9176   | 132.4037 | 240.2593 |
|           |       | count | 34       | 27       | 27       |
| Mecoprop  | mg/l  | min   | 0.04     | 0.02     | 0.05     |
|           |       | max   | 0.05     | 2.61     | 3.33     |
|           |       | mean  | 0.040164 | 0.343571 | 2.373571 |
|           |       | count | 61       | 28       | 28       |

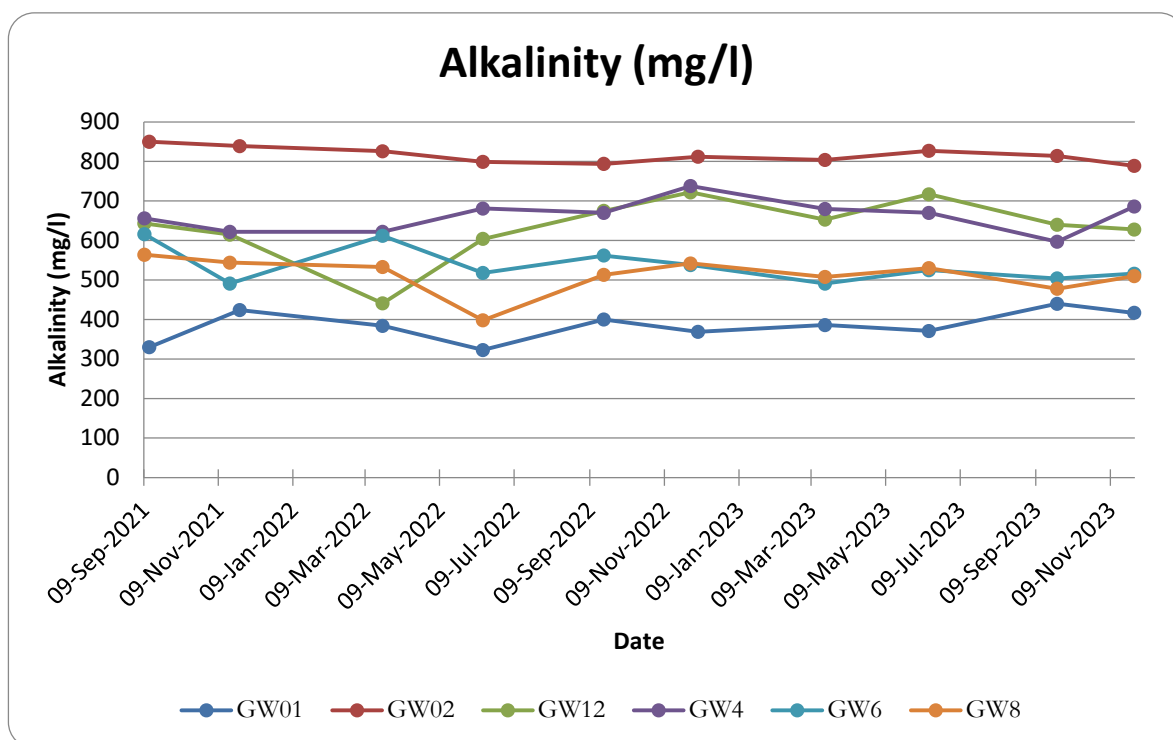


Figure 111: Alkalinity Concentration timeseries within the Trecatti Groundwater

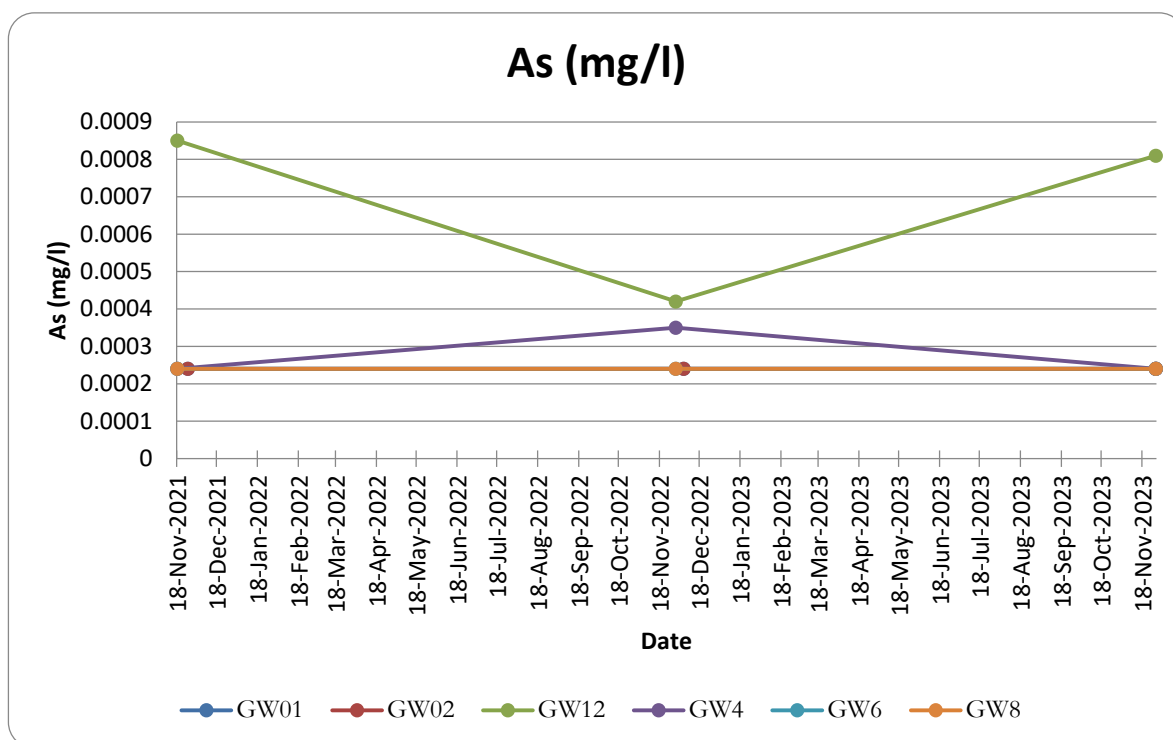


Figure 112: As Concentration timeseries within the Trecatti Groundwater

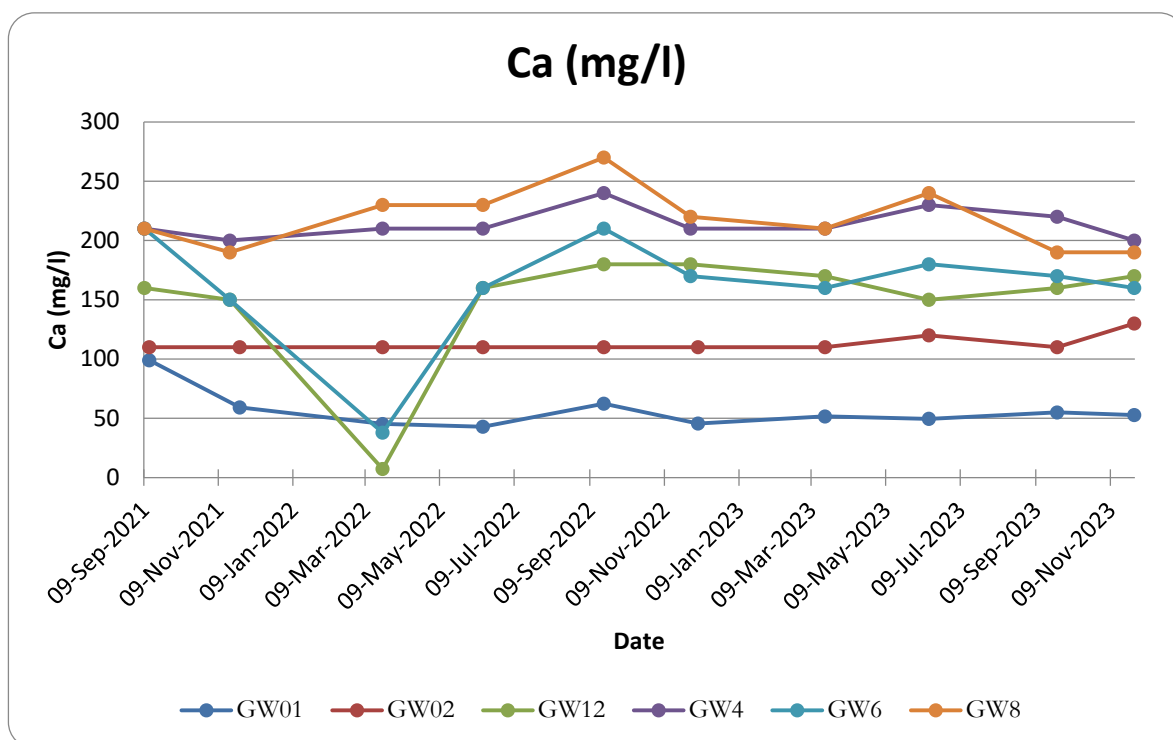


Figure 113: Ca Concentration timeseries within the Trecatti Groundwater

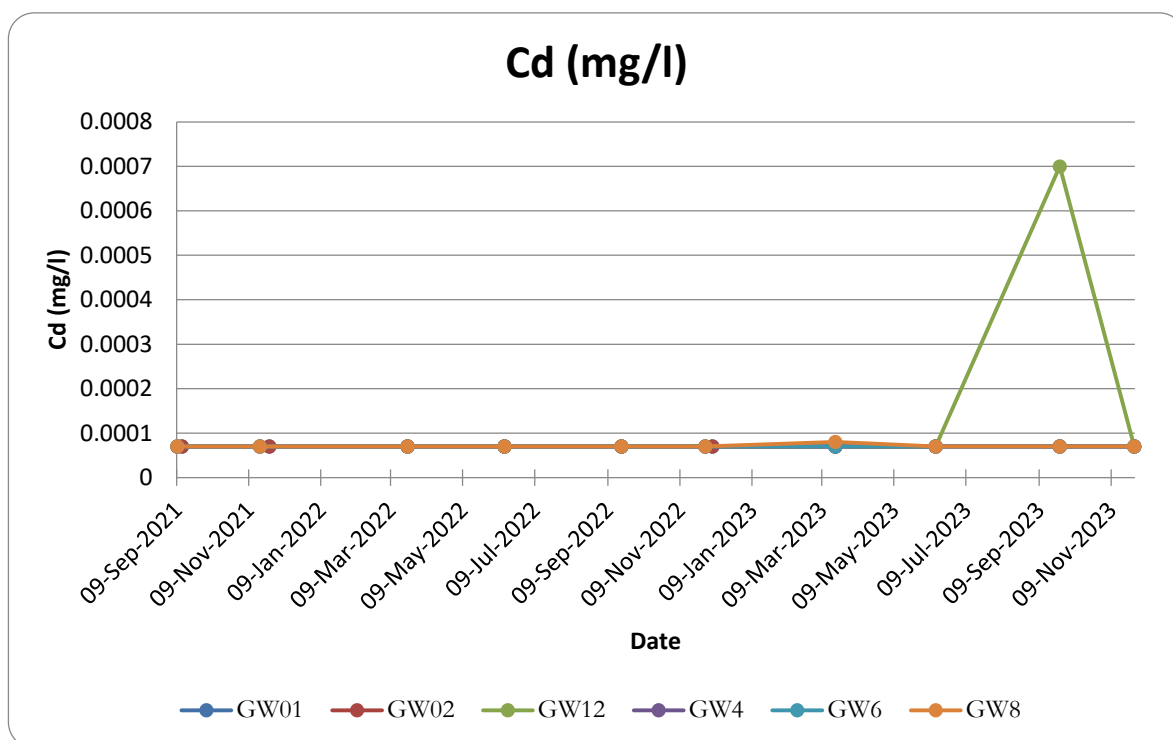


Figure 114: Cd Concentration timeseries within the Trecatti Groundwater

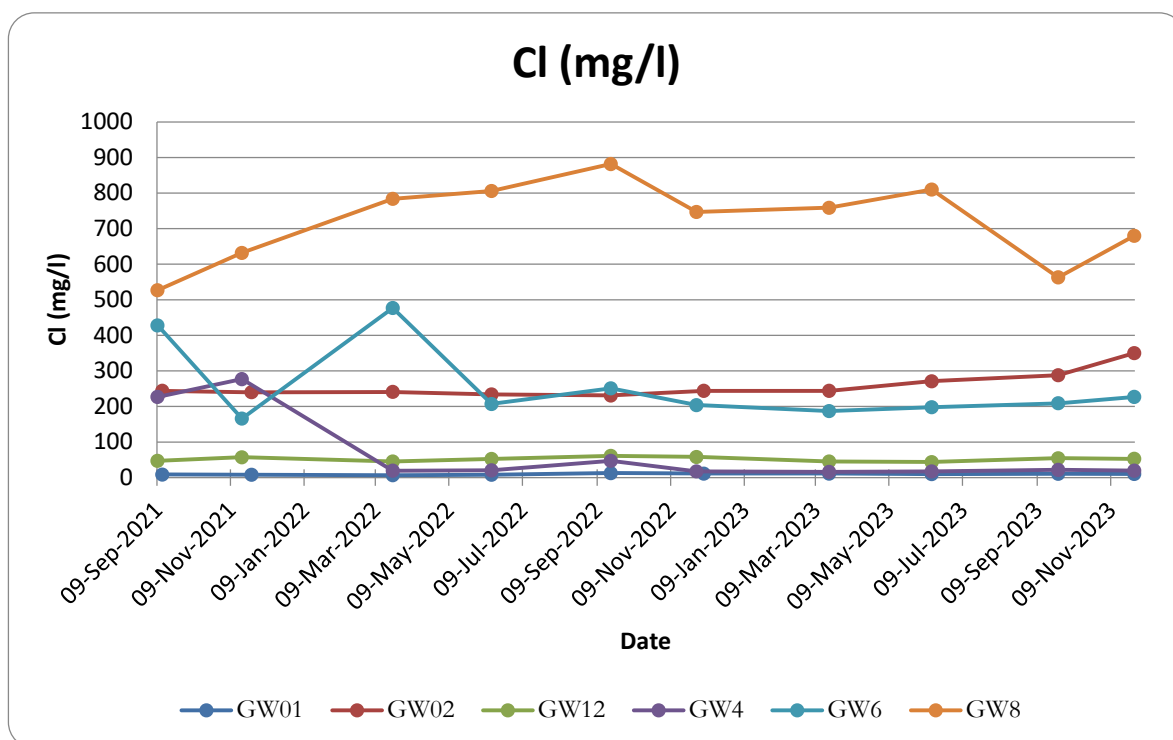


Figure 115: Cl Concentration timeseries within the Trecatti Groundwater

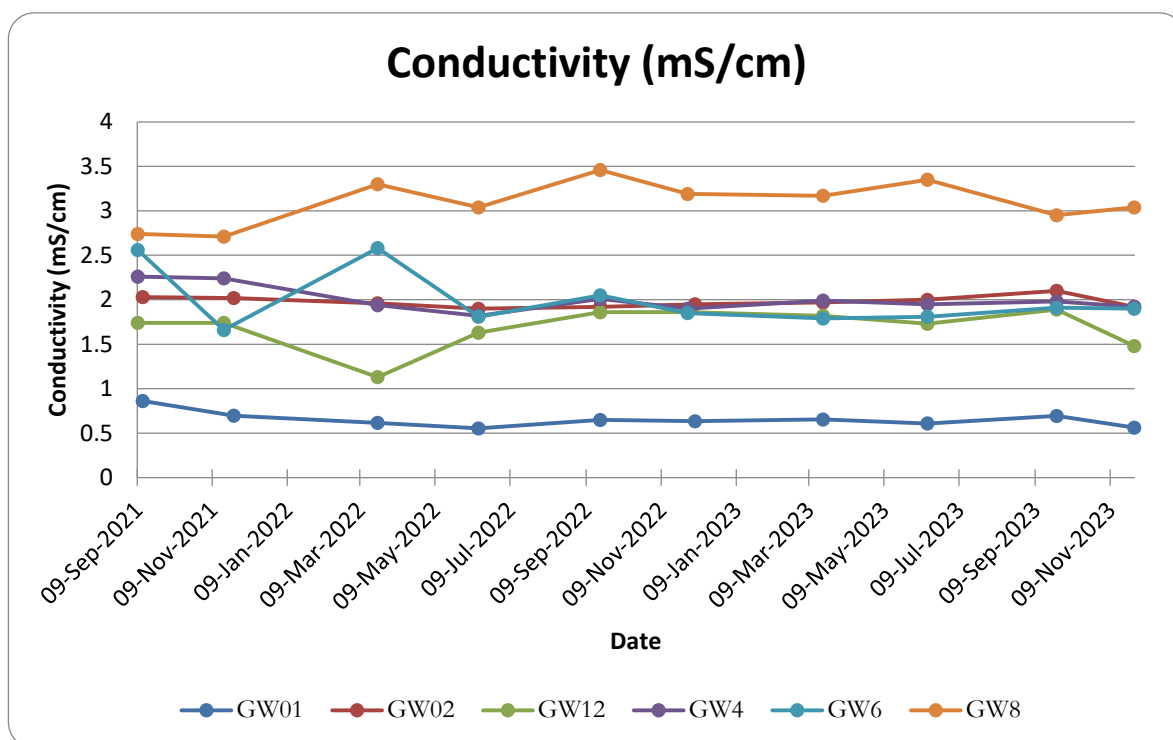


Figure 116: Electrical Conductivity timeseries within the Trecatti Groundwater

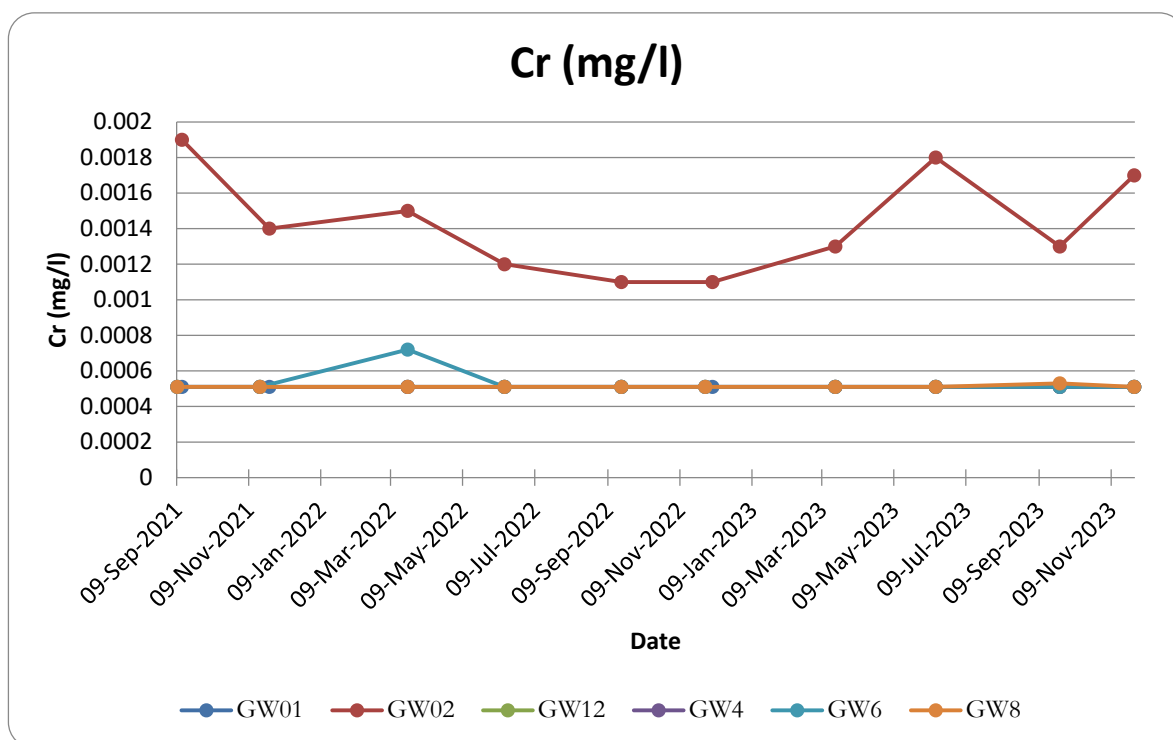


Figure 117:Cr Concentration timeseries within the Trecatti Groundwater

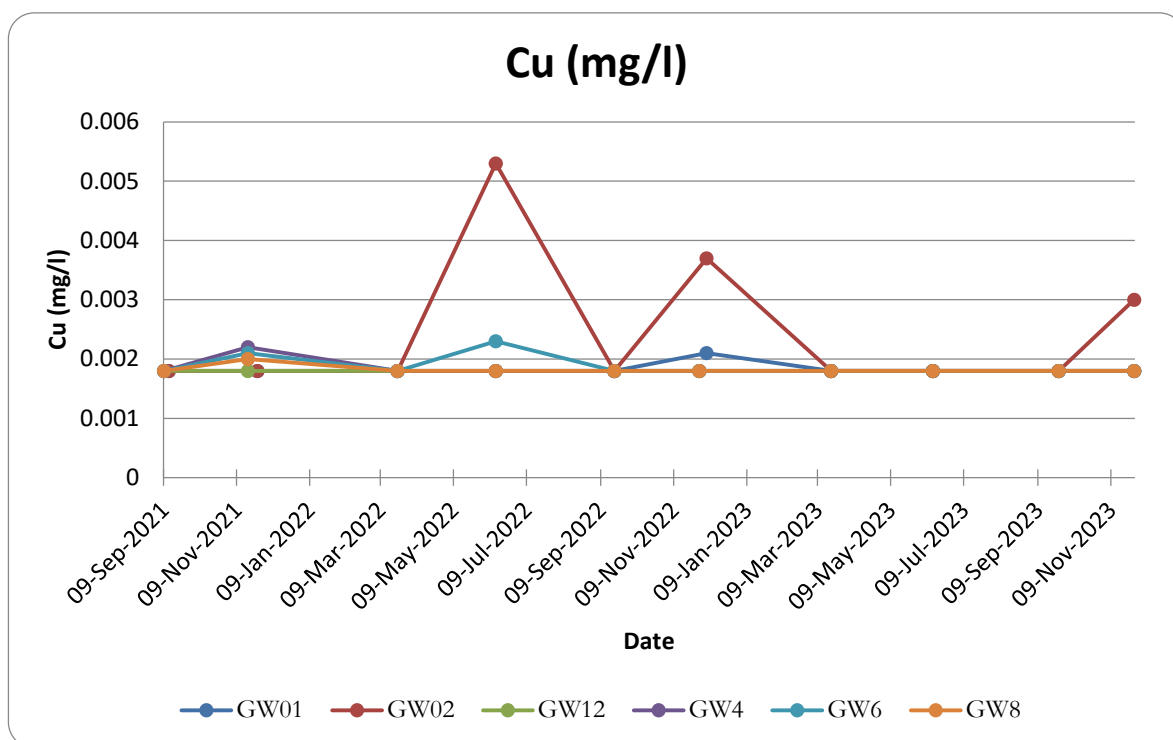


Figure 118:Cu Concentration timeseries within the Trecatti Groundwater

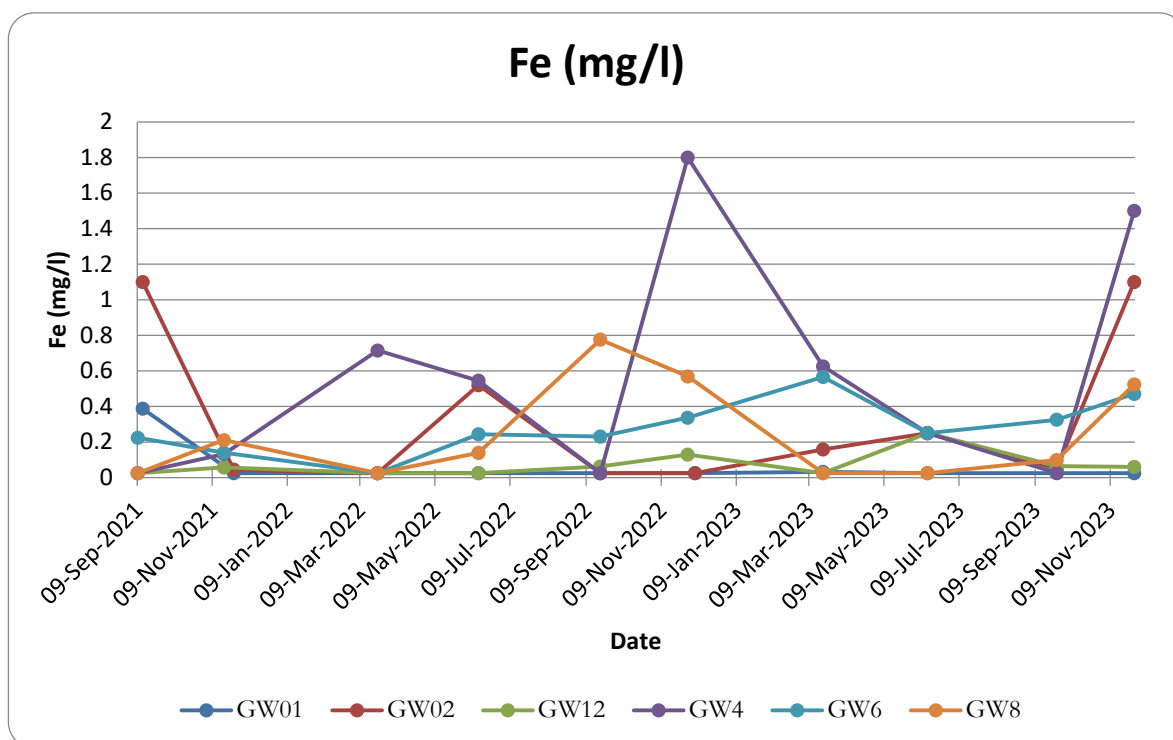


Figure 119: Fe Concentration timeseries within the Trecatti Groundwater

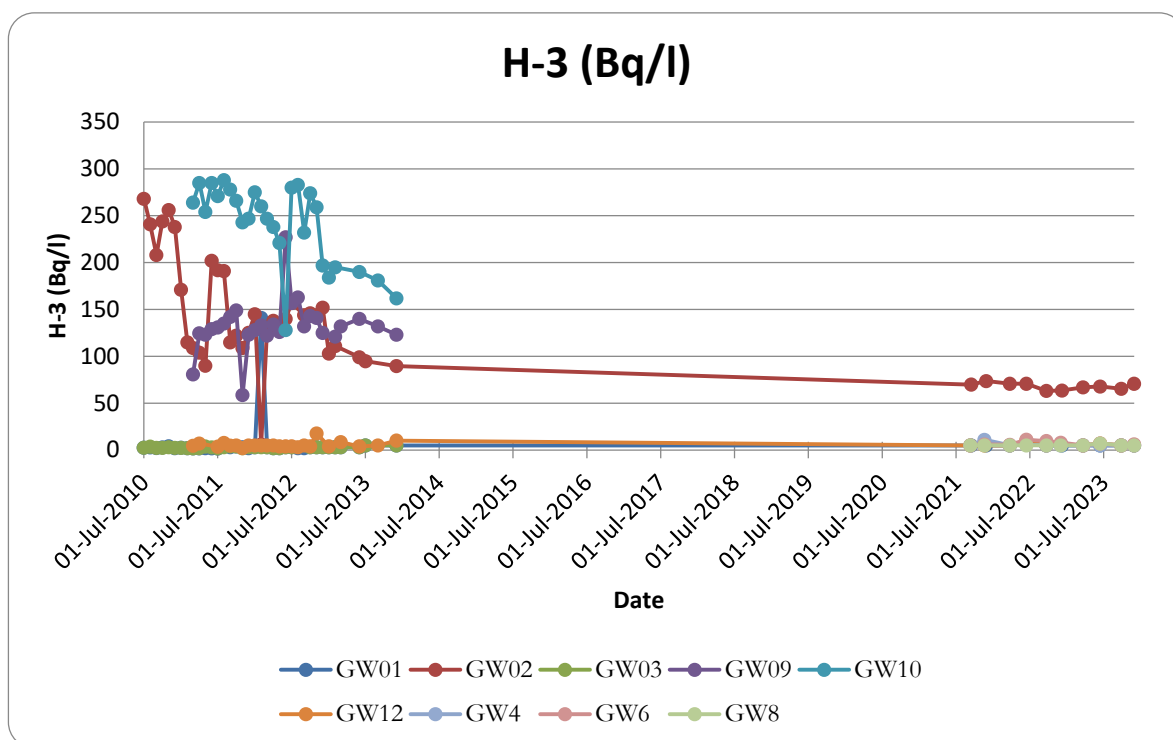


Figure 120: Tritium Concentration timeseries within the Trecatti Groundwater

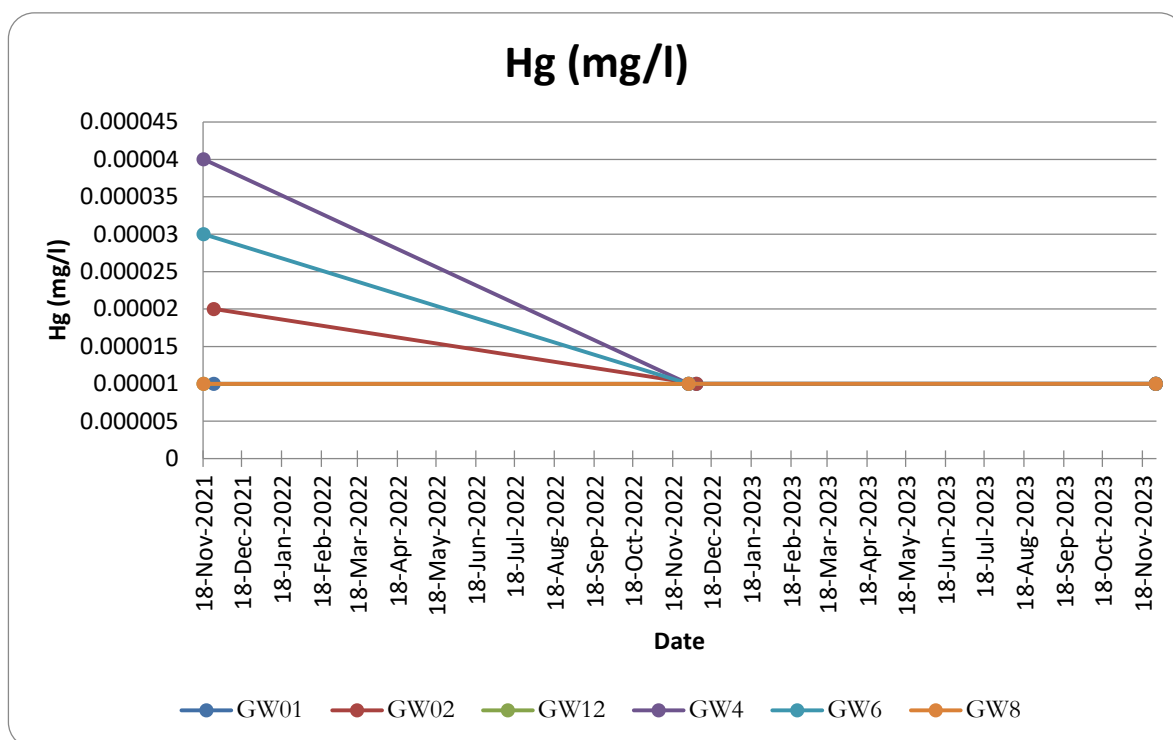


Figure 121: Hg Concentration timeseries within the Trecatti Groundwater

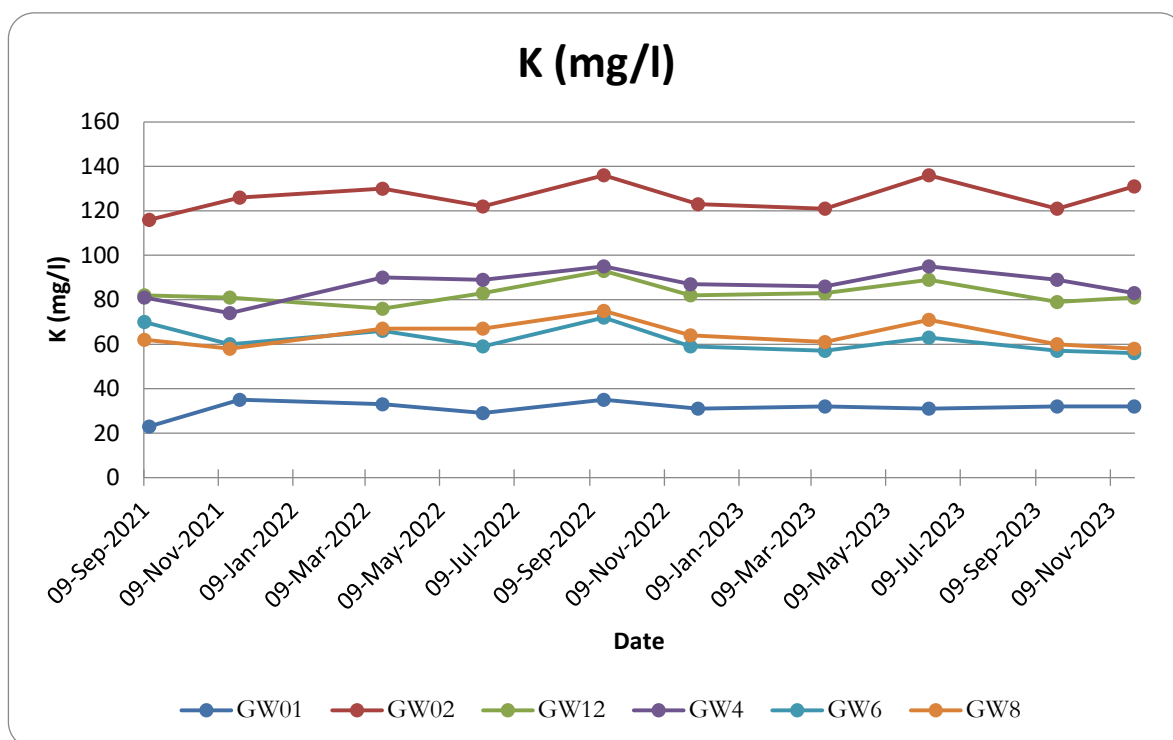


Figure 122: K Concentration timeseries within the Trecatti Groundwater

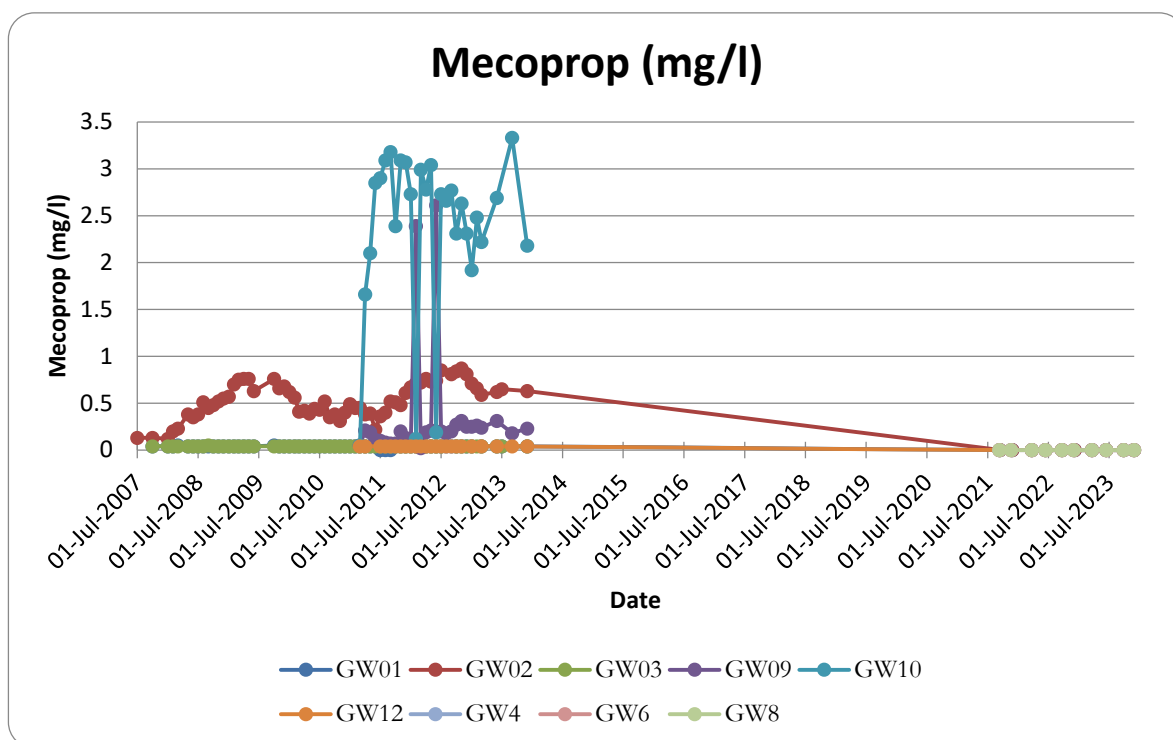


Figure 123: Mecoprop Concentration timeseries within the Trecatti Groundwater

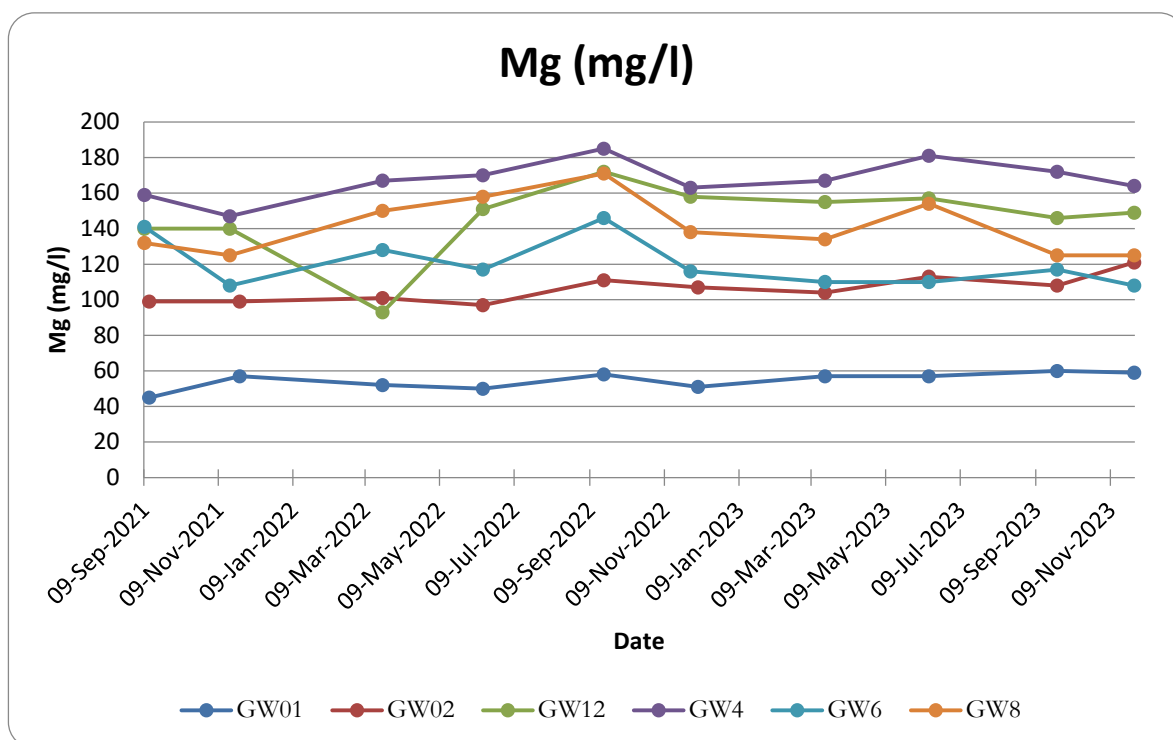


Figure 124: Mg Concentration timeseries within the Trecatti Groundwater

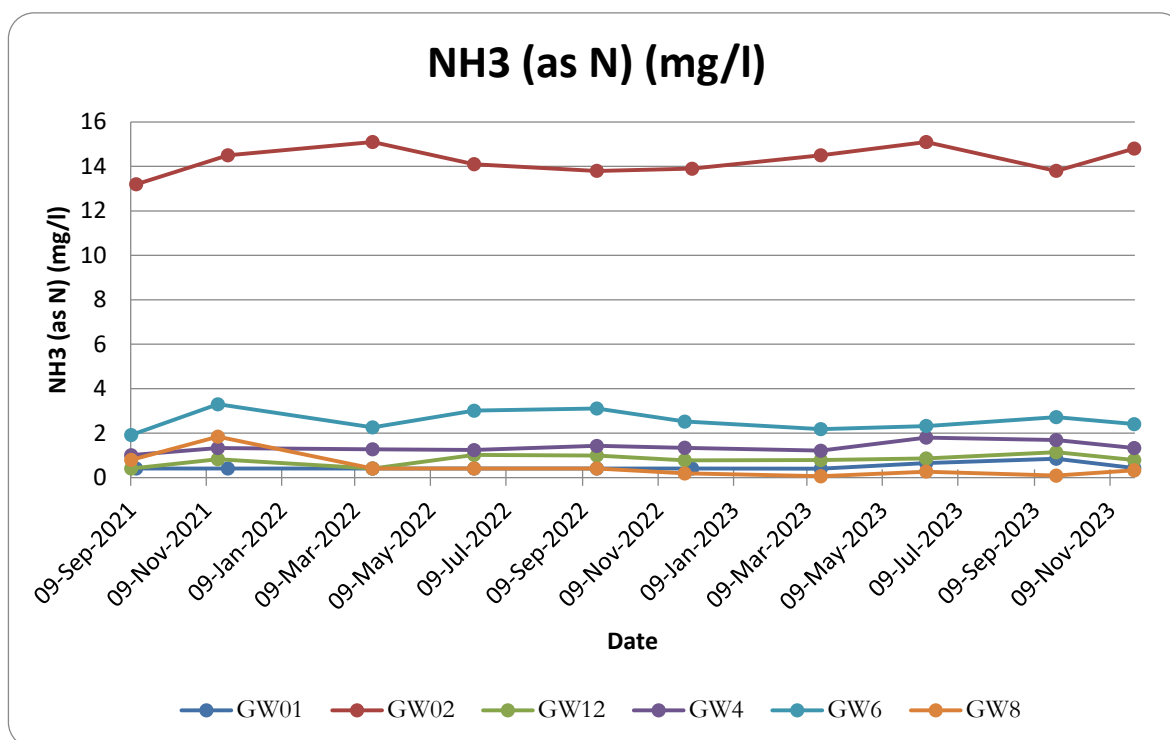


Figure 125: NH3 (as N) Concentration timeseries within the Trecatti Groundwater

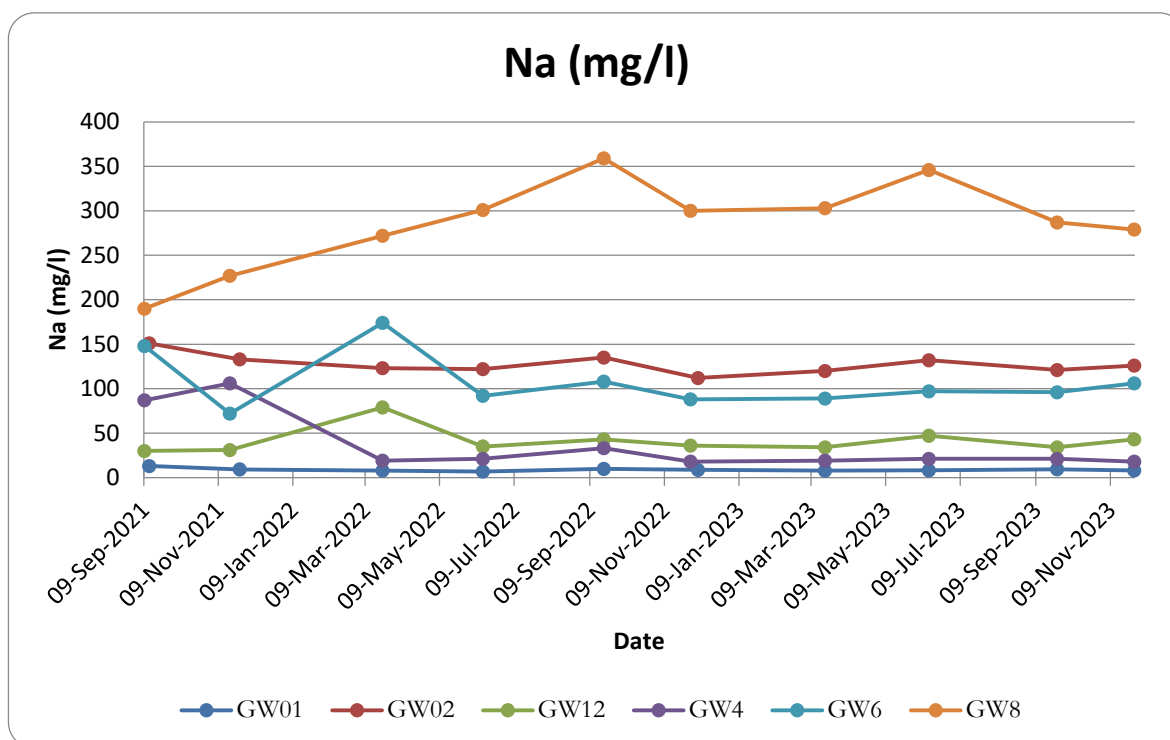


Figure 126: Na Concentration timeseries within the Trecatti Groundwater

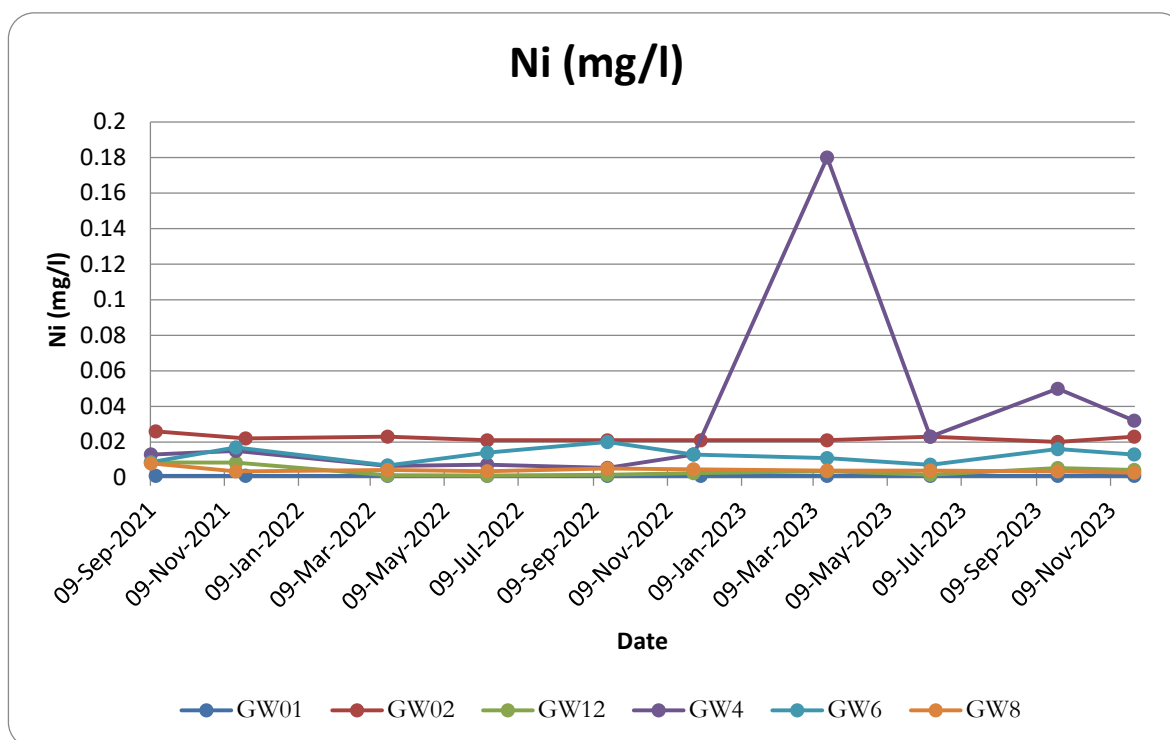


Figure 127: Ni Concentration timeseries within the Trecatti Groundwater

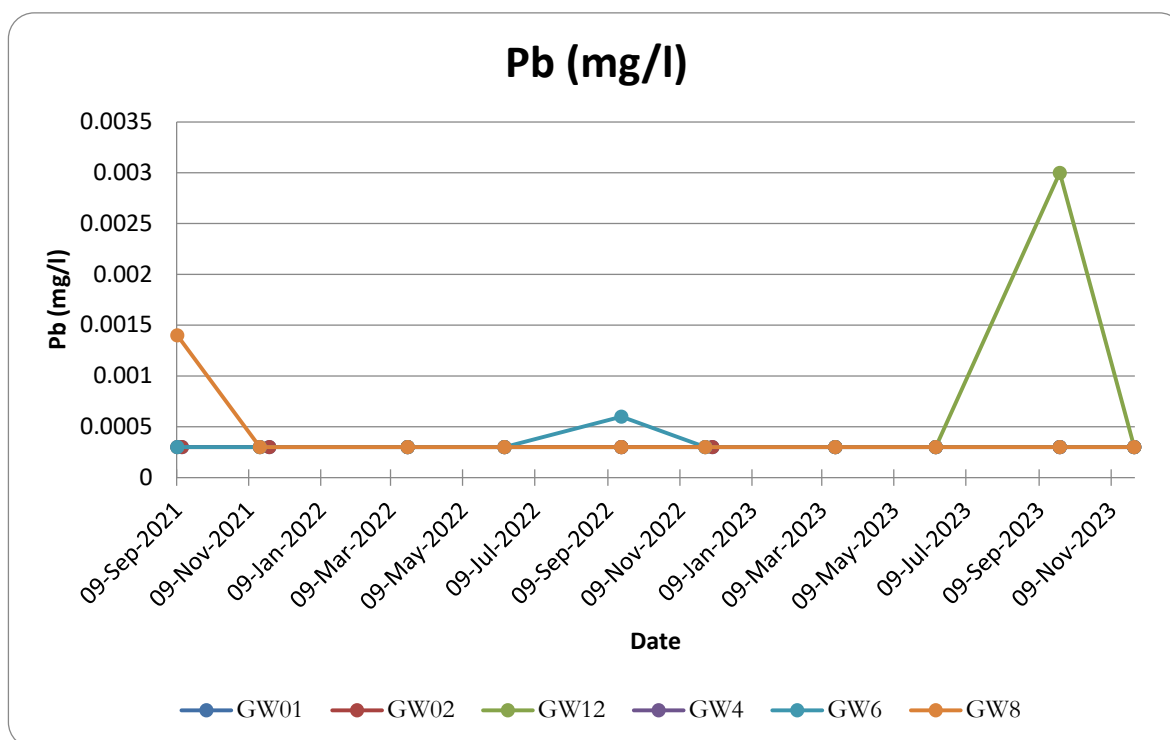


Figure 128: Pb Concentration timeseries within the Trecatti Groundwater

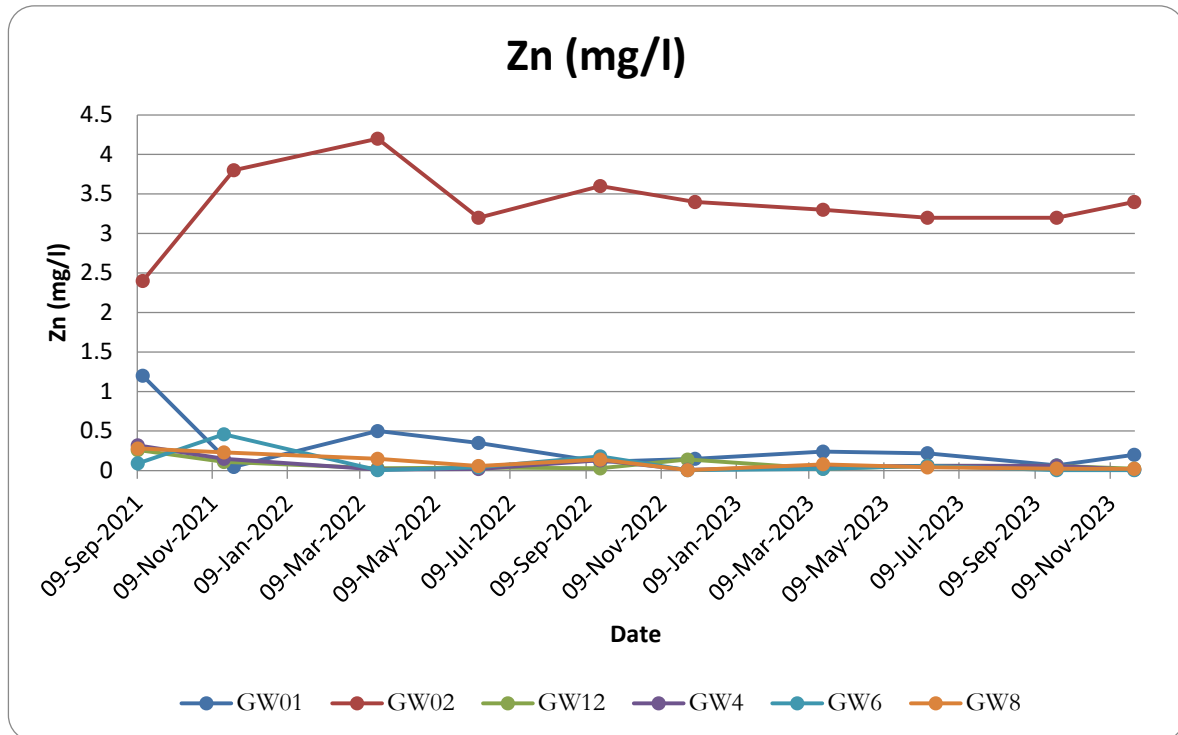


Figure 129: Zn Concentration timeseries within the Trecatti Groundwater

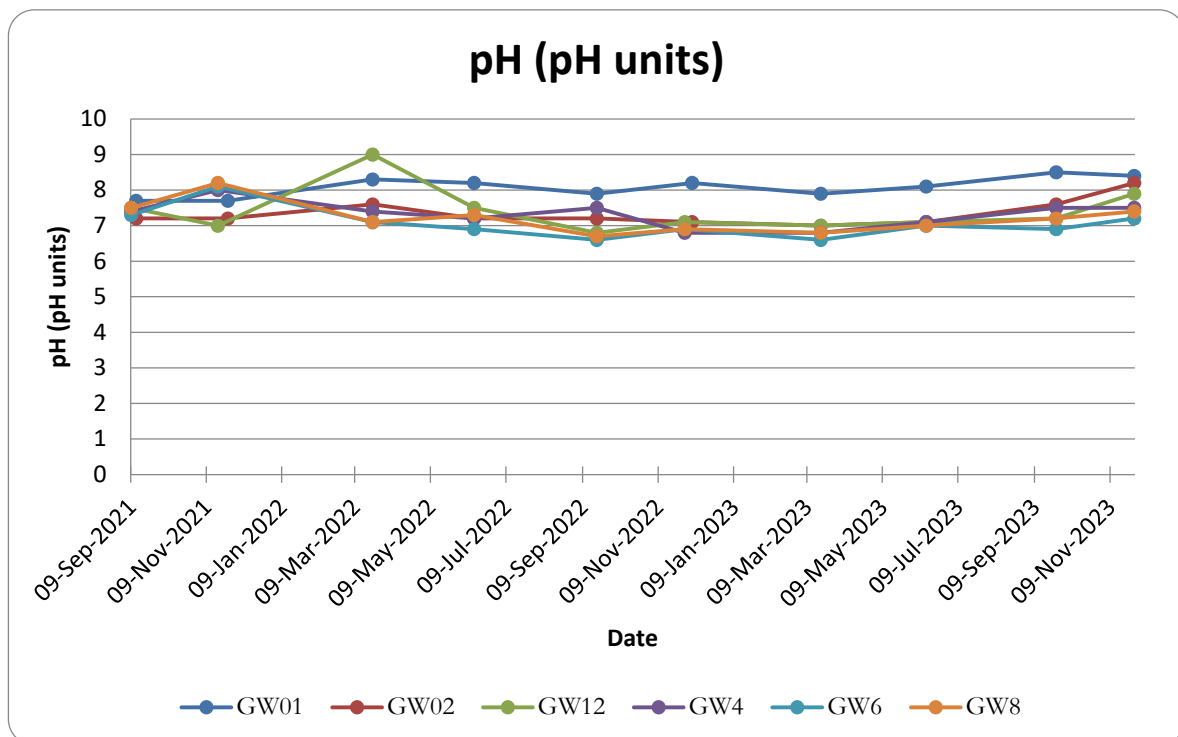


Figure 130: pH Concentration timeseries within the Trecatti Groundwater

## 9 GROUNDWATER

Table 10 Culvert Monitoring Point Statistics

| Parameter    | Units | Stat  | NL100    | NL169    | NL170    | NL175    | NL186    | NL192    |
|--------------|-------|-------|----------|----------|----------|----------|----------|----------|
| Al           | mg/l  | min   | 0.005    | 0.005    | 0.005    | 0.005    | 0.005    | 0.1      |
|              |       | max   | 11.1     | 3.2      | 85.6     | 6.64     | 8.34     | 3.17     |
|              |       | mean  | 1.41248  | 0.53977  | 3.27089  | 1.02973  | 1.36186  | 0.54553  |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Alkalinity   | mg/l  | min   | 175      | 162      | 130      | 152      | 132      | 142      |
|              |       | max   | 315      | 370      | 362      | 421      | 565      | 358      |
|              |       | mean  | 223.6552 | 215.9032 | 223.1136 | 306.3333 | 447.0345 | 226.1579 |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| As           | mg/l  | min   | 0.0002   | 0        | 0.0002   | 0.0004   | 0.0006   | 0.001    |
|              |       | max   | 0.027    | 0.016    | 0.0348   | 0.023    | 0.0317   | 1.465    |
|              |       | mean  | 0.005108 | 0.003528 | 0.006315 | 0.006312 | 0.010292 | 0.187427 |
|              |       | count | 25       | 25       | 40       | 25       | 25       | 15       |
| Ca           | mg/l  | min   | 44       | 26       | 31       | 25       | 29       | 27       |
|              |       | max   | 76       | 83       | 177      | 103      | 126      | 86       |
|              |       | mean  | 52.69    | 41.806   | 72.998   | 66.233   | 96.724   | 52.158   |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Cd           | mg/l  | min   | 0.00002  | 0.00002  | 0.00002  | 0.00002  | 0.00002  | 0.0006   |
|              |       | max   | 0.002    | 0.0018   | 0.0063   | 0.0028   | 0.001    | 0.0059   |
|              |       | mean  | 0.000546 | 0.000541 | 0.000814 | 0.000564 | 0.000522 | 0.001633 |
|              |       | count | 25       | 26       | 40       | 26       | 25       | 15       |
| Cl           | mg/l  | min   | 6        | 4        | 5        | 11       | 10       | 6        |
|              |       | max   | 23       | 22       | 15       | 29       | 39       | 15       |
|              |       | mean  | 12.8276  | 8.875    | 7.9714   | 18.4333  | 24.4828  | 10.1053  |
|              |       | count | 29       | 32       | 44       | 30       | 29       | 19       |
| Conductivity | mS/cm | min   | 342      | 350      | 646      | 401      | 455      | 313      |
|              |       | max   | 556      | 886      | 945      | 1000     | 1100     | 789      |
|              |       | mean  | 407.6207 | 510.7742 | 796.75   | 706.2667 | 936.3448 | 572.1579 |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Cr           | mg/l  | min   | 0.001    | 0.001    | 0.001    | 0.001    | 0.001    | 0.002    |
|              |       | max   | 0.0249   | 0.015    | 0.0124   | 0.0206   | 0.0313   | 0.01     |
|              |       | mean  | 0.00626  | 0.003192 | 0.00306  | 0.005365 | 0.007404 | 0.003533 |
|              |       | count | 25       | 26       | 40       | 26       | 25       | 15       |
| Cu           | mg/l  | min   | 0.001    | 0.0008   | 0.0005   | 0.0012   | 0.0006   | 0.009    |
|              |       | max   | 0.135    | 0.061    | 0.645    | 0.099    | 0.138    | 0.035    |
|              |       | mean  | 0.02584  | 0.01184  | 0.03631  | 0.01727  | 0.02195  | 0.01258  |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Fe           | mg/l  | min   | 0.005    | 0.011    | 0.005    | 0.015    | 0.009    | 0.23     |
|              |       | max   | 40.1     | 185      | 778      | 159      | 80       | 273      |
|              |       | mean  | 9.2104   | 14.4487  | 80.6918  | 14.8507  | 11.8244  | 67.5453  |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Hg           | mg/l  | min   | 0.00005  | 0.00005  | 0.00005  | 0.00005  | 0.00005  | 0.0001   |
|              |       | max   | 0.0001   | 0.0001   | 0.0053   | 0.0001   | 0.0001   | 0.0001   |
|              |       | mean  | 0.000094 | 9.42E-05 | 0.000248 | 9.42E-05 | 0.000094 | 0.0001   |
|              |       | count | 25       | 26       | 40       | 26       | 25       | 15       |
| K            | mg/l  | min   | 7        | 7        | 5        | 7        | 12       | 10       |
|              |       | max   | 15       | 35       | 60       | 74       | 61       | 31       |
|              |       | mean  | 9.34     | 13.77    | 18.78    | 33.43    | 45.9     | 19.32    |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Mg           | mg/l  | min   | 18       | 32       | 11       | 18       | 11       | 17       |
|              |       | max   | 59       | 72       | 147      | 76       | 81       | 68       |
|              |       | mean  | 21.448   | 40.355   | 62.098   | 43.433   | 61.828   | 40.632   |
|              |       | count | 29       | 31       | 44       | 30       | 29       | 19       |



| Parameter        | Units    | Stat  | NL100    | NL169    | NL170    | NL175    | NL186    | NL192    |
|------------------|----------|-------|----------|----------|----------|----------|----------|----------|
| Mn               | mg/l     | min   | 0.001    | 0.19     | 0.003    | 0.01     | 0.01     | 0.332    |
|                  |          | max   | 1.89     | 9.39     | 13.1     | 6.74     | 3.85     | 1.95     |
|                  |          | mean  | 0.59328  | 1.33442  | 1.46052  | 1.2271   | 0.72266  | 1.26668  |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Mo               | mg/l     | min   | 0.001    | 0.001    | 0.001    | 0.001    | 0.001    | 0.003    |
|                  |          | max   | 0.045    | 0.003    | 0.04     | 0.181    | 0.009    | 0.048    |
|                  |          | mean  | 0.0052   | 0.00254  | 0.0051   | 0.00938  | 0.00276  | 0.0066   |
|                  |          | count | 25       | 26       | 40       | 26       | 25       | 15       |
| N                | mg/l     | min   | 0.4      | 0.2      | 0.1      | 0.4      | 0.1      | 0.025    |
|                  |          | max   | 2.4      | 8.9      | 0.7      | 9.1      | 10.8     | 2.3      |
|                  |          | mean  | 0.8431   | 0.7645   | 0.3664   | 1.25     | 1.3166   | 0.4803   |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| NH3 (as N)       | mg/l     | min   | 0.09     | 0.08     | 0.05     | 0.14     | 0.06     | 0.27     |
|                  |          | max   | 0.38     | 0.6      | 0.98     | 1.6      | 1.4      | 1.01     |
|                  |          | mean  | 0.2503   | 0.2697   | 0.263    | 0.3567   | 0.6169   | 0.3326   |
|                  |          | count | 29       | 32       | 44       | 30       | 29       | 19       |
| Na               | mg/l     | min   | 0        | 5        | 2        | 4        | 6        | 4        |
|                  |          | max   | 29       | 10       | 19       | 16       | 18       | 7        |
|                  |          | mean  | 9.4828   | 6.1935   | 5.6827   | 8.9333   | 10.3793  | 4.8421   |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Ni               | mg/l     | min   | 0.002    | 0.003    | 0.002    | 0.003    | 0.001    | 0.003    |
|                  |          | max   | 0.056    | 0.092    | 0.04     | 0.101    | 0.042    | 0.064    |
|                  |          | mean  | 0.01636  | 0.02023  | 0.01018  | 0.01935  | 0.01396  | 0.02333  |
|                  |          | count | 25       | 26       | 40       | 26       | 25       | 15       |
| Pb               | mg/l     | min   | 0.0003   | 0.0003   | 0.0003   | 0.0003   | 0.0003   | 0.006    |
|                  |          | max   | 18.2     | 0.052    | 1.04     | 51.3     | 0.124    | 0.143    |
|                  |          | mean  | 0.645376 | 0.009868 | 0.047784 | 1.72513  | 0.017721 | 0.033474 |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| SO4              | mg/l     | min   | 7        | 60       | 61       | 32       | 19       | 35       |
|                  |          | max   | 28       | 170      | 342      | 194      | 154      | 267      |
|                  |          | mean  | 15.1034  | 78.129   | 264.4545 | 87.3333  | 105.6207 | 121      |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Se               | mg/l     | min   | 0.0005   | 0.0005   | 0.0005   | 0.0005   | 0.0005   | 0.0016   |
|                  |          | max   | 0.0035   | 0.002    | 0.0207   | 0.0029   | 0.0059   | 0.003    |
|                  |          | mean  | 0.001466 | 0.00144  | 0.002755 | 0.001452 | 0.0016   | 0.001858 |
|                  |          | count | 29       | 30       | 44       | 29       | 29       | 19       |
| Suspended Solids | mg/l     | min   | 120      | 36       | 10       | 132      | 175      | 12       |
|                  |          | max   | 4400     | 2080     | 25900    | 4930     | 7290     | 2340     |
|                  |          | mean  | 917.5172 | 485.6774 | 1945.386 | 733      | 953.6207 | 700.6842 |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| Zn               | mg/l     | min   | 0.004    | 0.005    | 0.003    | 0.003    | 0.002    | 0.018    |
|                  |          | max   | 0.637    | 0.394    | 0.779    | 0.313    | 0.609    | 0.183    |
|                  |          | mean  | 0.12141  | 0.05735  | 0.08127  | 0.08297  | 0.09817  | 0.06937  |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |
| pH               | pH units | min   | 7.3      | 6.4      | 6        | 6.5      | 6.7      | 6.5      |
|                  |          | max   | 8        | 8.3      | 7.9      | 8.4      | 8        | 7.2      |
|                  |          | mean  | 7.579    | 6.916    | 7.057    | 7.29     | 7.448    | 6.895    |
|                  |          | count | 29       | 31       | 44       | 30       | 29       | 19       |

Table 11 Culvert Monitoring Point Statistics

| Parameter | Units | Stat | 5808A | 5812  | 5824 | OB1  | SC01 | SC02 | SHAFT |
|-----------|-------|------|-------|-------|------|------|------|------|-------|
| Al        | mg/l  | min  | 0.005 | 0.005 | 0    | 0.01 | 0.01 | 0.01 | 0.01  |
|           |       | max  | 2.36  | 1.1   | 1.4  | 0.01 | 0.17 | 0.06 | 0.291 |



| Parameter    | Units | Stat  | 5808A    | 5812     | 5824     | OB1     | SC01     | SC02     | SHAFT    |
|--------------|-------|-------|----------|----------|----------|---------|----------|----------|----------|
|              |       | mean  | 0.13685  | 0.16833  | 0.1199   | 0.01    | 0.02724  | 0.025    | 0.08125  |
|              |       | count | 39       | 39       | 63       | 1       | 21       | 4        | 44       |
|              |       | min   | 370      | 483      | 23       | 241     | 460      | 50       | 177      |
|              |       | max   | 895      | 1090     | 579      | 241     | 601      | 280      | 277      |
| Alkalinity   | mg/l  | mean  | 570.2941 | 823.3846 | 260.0983 | 241     | 521.1429 | 195.6667 | 237.8182 |
|              |       | count | 34       | 39       | 58       | 1       | 14       | 3        | 44       |
|              |       | min   | 0.001    | 0.001    | 0.0004   | 0.001   | 0.01     | 0.01     | 0        |
|              |       | max   | 0.01     | 0.152    | 0.015    | 0.001   | 0.01     | 0.01     | 0.011    |
| As           | mg/l  | mean  | 0.003858 | 0.011137 | 0.0026   | 0.001   | 0.01     | 0.01     | 0.001318 |
|              |       | count | 24       | 38       | 42       | 1       | 2        | 3        | 40       |
|              |       | min   | 65       | 75.6     | 6        | 64      | 37       | 9        | 47       |
|              |       | max   | 228      | 138      | 75       | 64      | 118      | 53       | 92       |
| Ca           | mg/l  | mean  | 120.786  | 125.94   | 27.123   | 64      | 91.87    | 32.2     | 61.295   |
|              |       | count | 42       | 40       | 65       | 1       | 23       | 5        | 44       |
|              |       | min   | 0.00002  | 0.00002  | 0        | 0.00002 | 0.002    | 0.002    | 0.00002  |
|              |       | max   | 0.002    | 0.0006   | 0.002    | 0.00002 | 0.002    | 0.002    | 0.0011   |
| Cd           | mg/l  | mean  | 0.000462 | 0.00022  | 0.000281 | 0.00002 | 0.002    | 0.002    | 0.000437 |
|              |       | count | 25       | 39       | 43       | 1       | 2        | 3        | 40       |
|              |       | min   | 30       | 38       | 6        | 11      | 6        | 5        | 16       |
|              |       | max   | 601      | 915      | 1450     | 11      | 95       | 12       | 51       |
| Cl           | mg/l  | mean  | 95.3193  | 447.98   | 36.9692  | 11      | 44.7273  | 7.8      | 25.5227  |
|              |       | count | 57       | 50       | 65       | 1       | 22       | 5        | 44       |
|              |       | min   | 341      | 197      | 0.227    |         | 310      | 190      | 503      |
|              |       | max   | 3530     | 4450     | 1170     |         | 1420     | 666      | 800      |
| Conductivity | mS/cm | mean  | 1408.711 | 3039.925 | 484.972  |         | 1172     | 441.5    | 655.3182 |
|              |       | count | 38       | 40       | 62       |         | 17       | 4        | 44       |
|              |       | min   | 0.001    | 0.001    | 0.001    | 0.001   | 0.01     | 0.01     | 0.001    |
|              |       | max   | 0.033    | 0.042    | 0.01     | 0.001   | 0.01     | 0.01     | 0.023    |
| Cr           | mg/l  | mean  | 0.00432  | 0.004385 | 0.002093 | 0.001   | 0.01     | 0.01     | 0.0024   |
|              |       | count | 25       | 39       | 43       | 1       | 2        | 3        | 40       |
|              |       | min   | 0.0008   | 0.001    | 0        | 0.001   | 0.001    | 0.005    | 0.0005   |
|              |       | max   | 0.03     | 0.036    | 0.774    | 0.001   | 0.04     | 0.01     | 0.26     |
| Cu           | mg/l  | mean  | 0.00509  | 0.00579  | 0.01672  | 0.001   | 0.0081   | 0.00875  | 0.01364  |
|              |       | count | 41       | 39       | 64       | 1       | 21       | 4        | 44       |
|              |       | min   | 0.017    | 0.031    | 0.005    | 0.01    | 0.09     | 0.02     | 0.005    |
|              |       | max   | 8.08     | 33.6     | 17.4     | 0.01    | 26.1     | 6.74     | 100      |
| Fe           | mg/l  | mean  | 1.7647   | 3.7602   | 1.3328   | 0.01    | 5.5414   | 2.642    | 6.2646   |



| Parameter  | Units | Stat  | 5808A    | 5812     | 5824     | OB1     | SC01   | SC02   | SHAFT    |
|------------|-------|-------|----------|----------|----------|---------|--------|--------|----------|
| H-3        | Bq/l  | count | 41       | 40       | 64       | 1       | 22     | 5      | 44       |
|            |       | min   | 5        | 4.6      |          |         | 15     |        |          |
|            |       | max   | 92.2     | 150      |          |         | 17     |        |          |
|            |       | mean  | 21.5907  | 40.5474  |          |         | 16     |        |          |
|            |       | count | 75       | 57       |          |         | 2      |        |          |
| Hg         | mg/l  | min   | 0.00005  | 0.00003  | 0.00003  | 0.00003 | 0.001  | 0.001  | 0.00005  |
|            |       | max   | 0.001    | 0.0005   | 0.002    | 0.00003 | 0.001  | 0.001  | 0.0001   |
|            |       | mean  | 0.000172 | 8.69E-05 | 0.000188 | 0.00003 | 0.001  | 0.001  | 8.63E-05 |
|            |       | count | 25       | 39       | 43       | 1       | 2      | 3      | 40       |
| K          | mg/l  | min   | 12       | 64.7     | 3        | 45      | 24     | 5      | 4        |
|            |       | max   | 93       | 95       | 24       | 45      | 60     | 28     | 21       |
|            |       | mean  | 63.08    | 84.47    | 9.19     | 45      | 44.48  | 15     | 15.73    |
|            |       | count | 44       | 40       | 67       | 1       | 23     | 5      | 44       |
| Mecoprop   | mg/l  | min   | 0.02     | 0.02     | 0.00002  |         | 0.02   |        |          |
|            |       | max   | 0.18     | 0.15     | 0.1      |         | 0.06   |        |          |
|            |       | mean  | 0.0426   | 0.0422   | 0.0192   |         | 0.0288 |        |          |
|            |       | count | 82       | 59       | 12       |         | 16     |        |          |
| Mg         | mg/l  | min   | 59       | 60       | 1        | 78      | 25     | 14     | 29       |
|            |       | max   | 157      | 118      | 28       | 78      | 109    | 60     | 54       |
|            |       | mean  | 83.117   | 84.975   | 5.354    | 78      | 90.826 | 32.2   | 42.636   |
|            |       | count | 42       | 40       | 65       | 1       | 23     | 5      | 44       |
| Mn         | mg/l  | min   | 0.005    | 0.101    | 0        |         | 0.002  | 0.01   | 0.009    |
|            |       | max   | 2.185    | 2.15     | 0.39     |         | 3.938  | 1.02   | 3.71     |
|            |       | mean  | 0.5154   | 0.6778   | 0.05796  |         | 0.2711 | 0.2625 | 0.30834  |
|            |       | count | 40       | 40       | 57       |         | 21     | 4      | 44       |
| Mo         | mg/l  | min   | 0.001    | 0.001    | 0.001    |         | 0.01   | 0.01   | 0.001    |
|            |       | max   | 0.277    | 0.452    | 0.01     |         | 0.01   | 0.01   | 0.029    |
|            |       | mean  | 0.01461  | 0.01687  | 0.00151  |         | 0.01   | 0.01   | 0.00325  |
|            |       | count | 23       | 39       | 41       |         | 1      | 1      | 40       |
| N          | mg/l  | min   | 0.1      | 0        | 0.16     |         | 0      | 0.3    | 0.1      |
|            |       | max   | 2.4      | 1.9      | 1.9      |         | 5.1    | 0.5    | 1.3      |
|            |       | mean  | 0.46     | 0.5368   | 0.4219   |         | 0.6429 | 0.45   | 0.525    |
|            |       | count | 40       | 38       | 58       |         | 21     | 4      | 44       |
| NH3 (as N) | mg/l  | min   | 0.01     | 0.03     | 0.01     |         | 0.01   | 0.02   | 0.01     |
|            |       | max   | 34.1     | 3.5      | 1.2      |         | 0.4    | 0.7    | 0.6      |
|            |       | mean  | 2.6441   | 1.6351   | 0.1936   |         | 0.1091 | 0.204  | 0.2164   |
|            |       | count | 58       | 51       | 67       |         | 23     | 5      | 44       |



| Parameter        | Units    | Stat  | 5808A        | 5812         | 5824         | OB1    | SC01         | SC02    | SHAFT        |
|------------------|----------|-------|--------------|--------------|--------------|--------|--------------|---------|--------------|
| Na               | mg/l     | min   | 12           | 25           | 4            | 10     | 10           | 3       | 9            |
|                  |          | max   | 312          | 1300         | 197          | 10     | 28           | 10      | 31           |
|                  |          | mean  | 64.0614      | 410.365      | 95.2239      | 10     | 16.3913      | 5.8     | 12.7727      |
|                  |          | count | 44           | 40           | 67           | 1      | 23           | 5       | 44           |
| Ni               | mg/l     | min   | 0.007        | 0.007        | 0            | 0.03   | 0.02         | 0.02    | 0.003        |
|                  |          | max   | 0.08         | 0.06         | 0.02         | 0.03   | 0.02         | 0.02    | 0.118        |
|                  |          | mean  | 0.02428      | 0.03297      | 0.00549      | 0.03   | 0.02         | 0.02    | 0.0117       |
|                  |          | count | 25           | 39           | 43           | 1      | 2            | 3       | 40           |
| Pb               | mg/l     | min   | 0.0003       | 0.0003       | 0.0002       | 0.0002 | 0.001        | 0.004   | 0.0003       |
|                  |          | max   | 0.018        | 0.061        | 0.26         | 0.0002 | 0.015        | 0.012   | 0.021        |
|                  |          | mean  | 0.00336      | 0.00496<br>4 | 0.00625<br>8 | 0.0002 | 0.004        | 0.00675 | 0.00490<br>5 |
|                  |          | count | 40           | 39           | 64           | 1      | 21           | 4       | 44           |
| SO4              | mg/l     | min   | 1.3          | 6            | 0.4          | 273    | 20           | 22      | 83           |
|                  |          | max   | 488          | 373          | 1540         | 273    | 192          | 110     | 148          |
|                  |          | mean  | 155.445<br>5 | 146.905      | 41.9701      | 273    | 127.521<br>7 | 63.3333 | 105.954<br>5 |
|                  |          | count | 44           | 40           | 67           | 1      | 23           | 6       | 44           |
| Se               | mg/l     | min   | 0.001        | 0.001        | 0.0005       |        | 0.001        | 0.002   | 0.0005       |
|                  |          | max   | 0.0082       | 0.031        | 0.002        |        | 0.002        | 0.003   | 0.0026       |
|                  |          | mean  | 0.00200<br>6 | 0.00437<br>9 | 0.00108<br>6 |        | 0.00115<br>3 | 0.00225 | 0.00140<br>2 |
|                  |          | count | 34           | 38           | 59           |        | 17           | 4       | 44           |
| Suspended Solids | mg/l     | min   | 2            | 54           | 12           | 5      | 18           | 13      | 1            |
|                  |          | max   | 635          | 720          | 16970        | 5      | 1080         | 1770    | 365          |
|                  |          | mean  | 122.75       | 224.975      | 415.030<br>8 | 5      | 255.347<br>8 | 400.4   | 35.9545<br>5 |
|                  |          | count | 42           | 40           | 65           | 1      | 23           | 5       | 44           |
| Zn               | mg/l     | min   | 0.002        | 0.005        | 0            | 0.01   | 0.002        | 0.01    | 0.002        |
|                  |          | max   | 0.06         | 0.4          | 0.416        | 0.01   | 0.066        | 0.11    | 0.5          |
|                  |          | mean  | 0.01539      | 0.05759      | 0.02272      | 0.01   | 0.01868      | 0.04    | 0.034        |
|                  |          | count | 41           | 39           | 64           | 1      | 22           | 5       | 44           |
| pH               | pH units | min   | 6.9          | 7.1          | 6.8          | 8.3    | 6.4          | 6.8     | 6.6          |
|                  |          | max   | 8.7          | 8.4          | 8.5          | 8.3    | 8.4          | 8.3     | 8.3          |
|                  |          | mean  | 7.479        | 7.505        | 7.642        | 8.3    | 6.938        | 7.433   | 7.134        |
|                  |          | count | 43           | 40           | 66           | 1      | 24           | 6       | 44           |

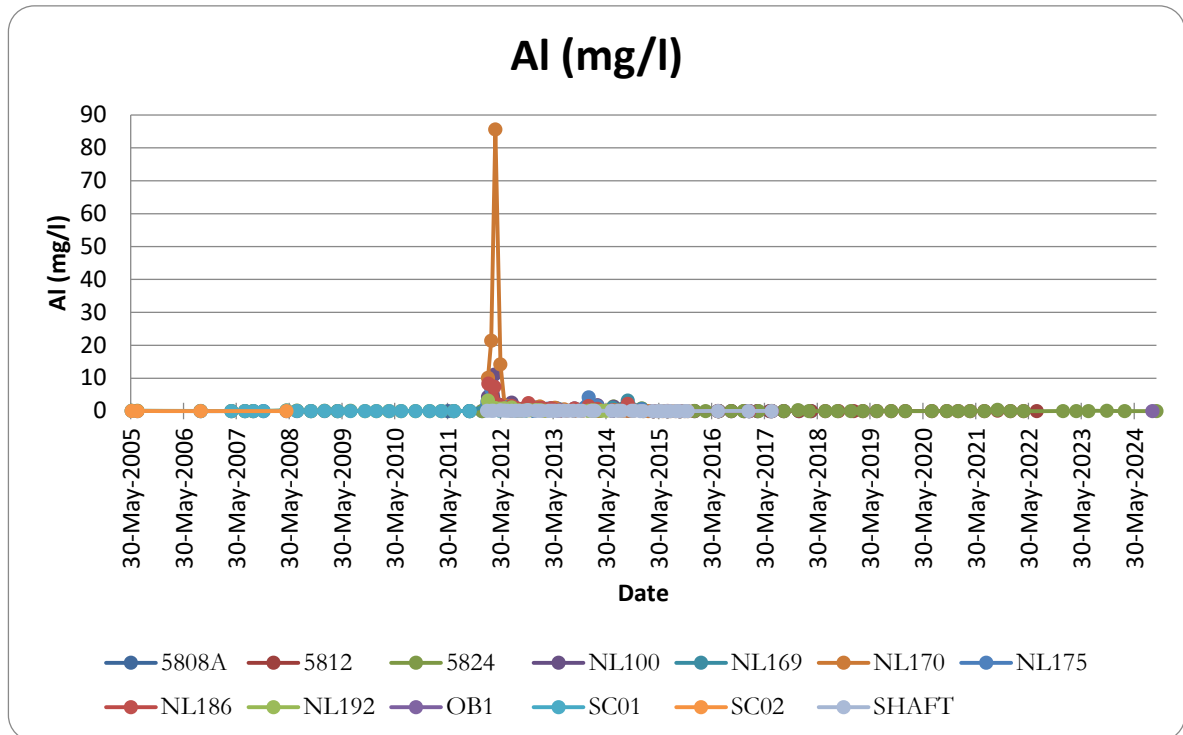


Figure 131: Al Concentration timeseries within the Groundwater

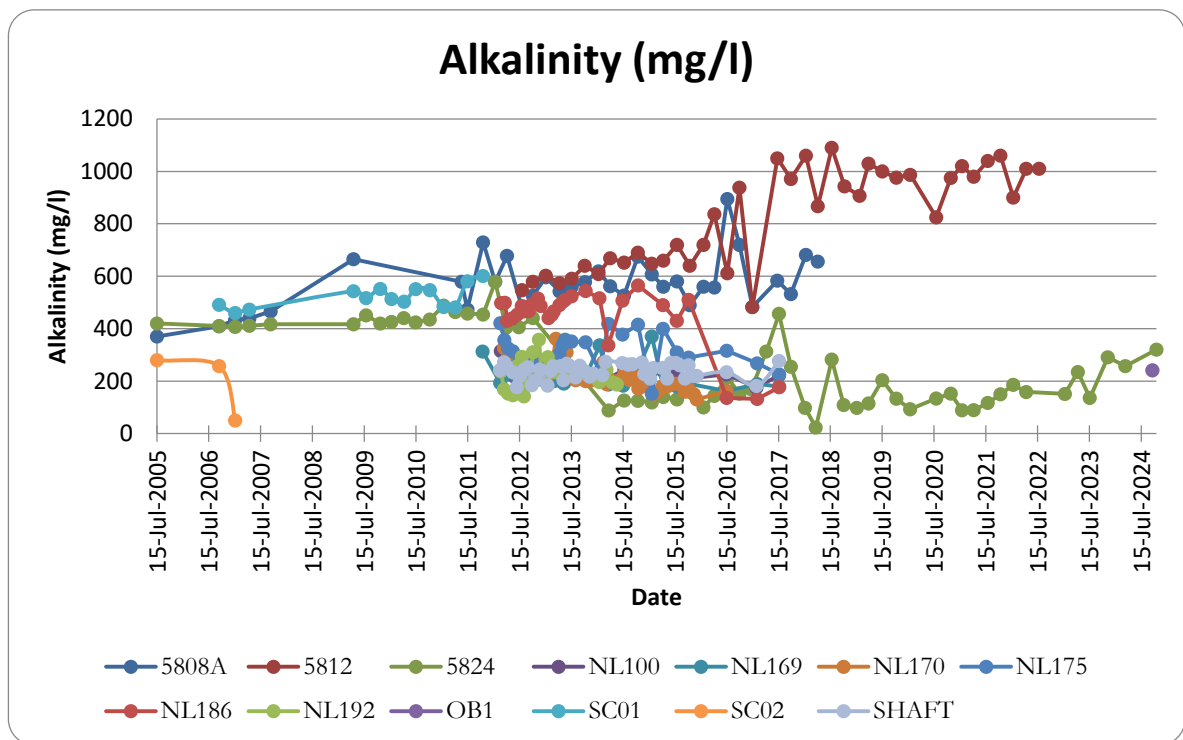


Figure 132: Alkalinity Concentration timeseries within the Groundwater

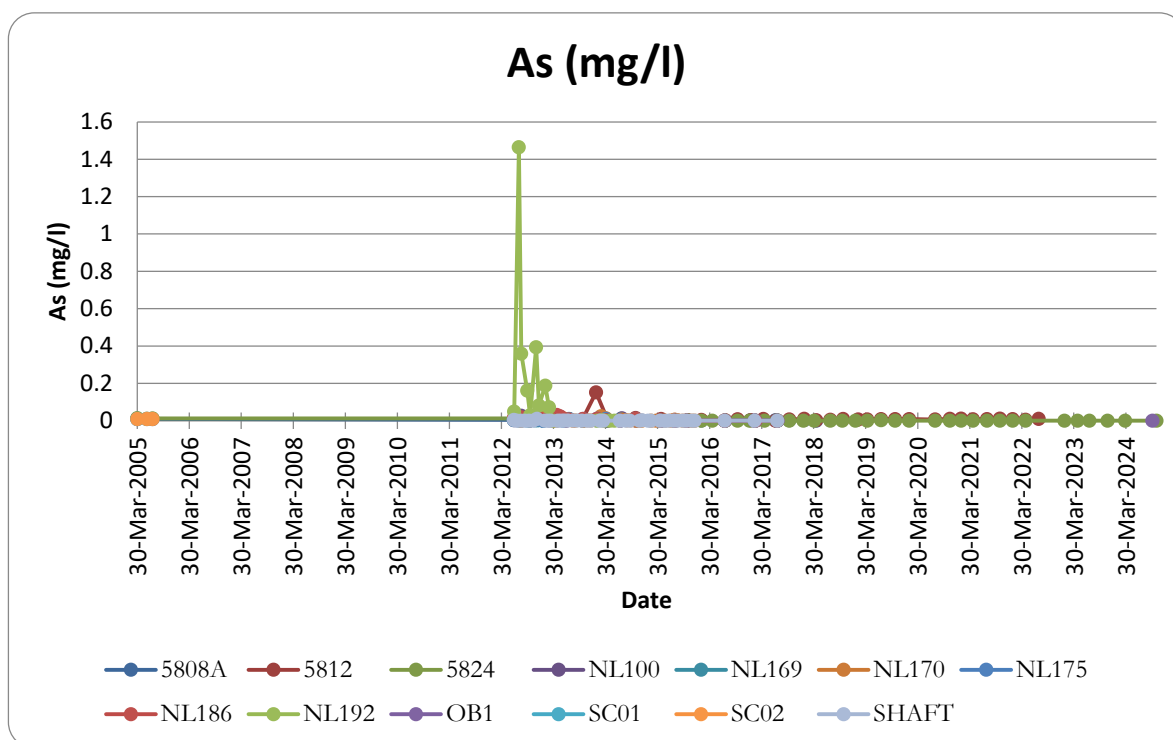


Figure 133: As Concentration timeseries within the Groundwater

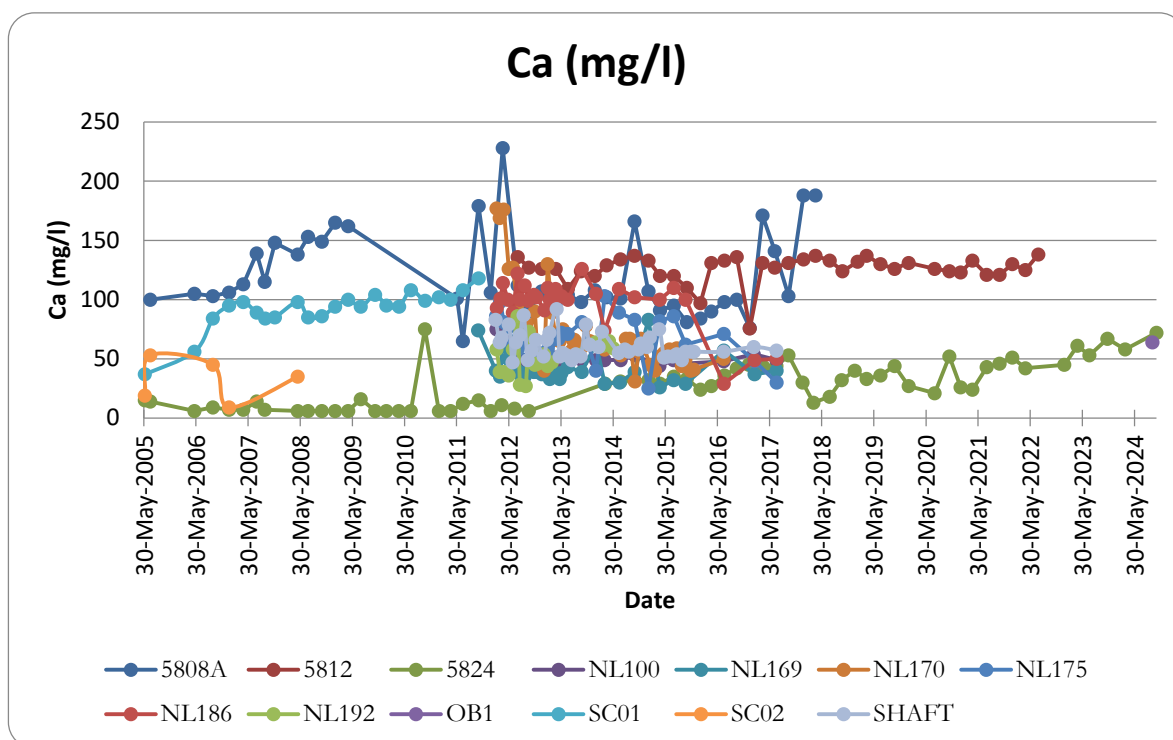


Figure 134: Ca Concentration timeseries within the Groundwater

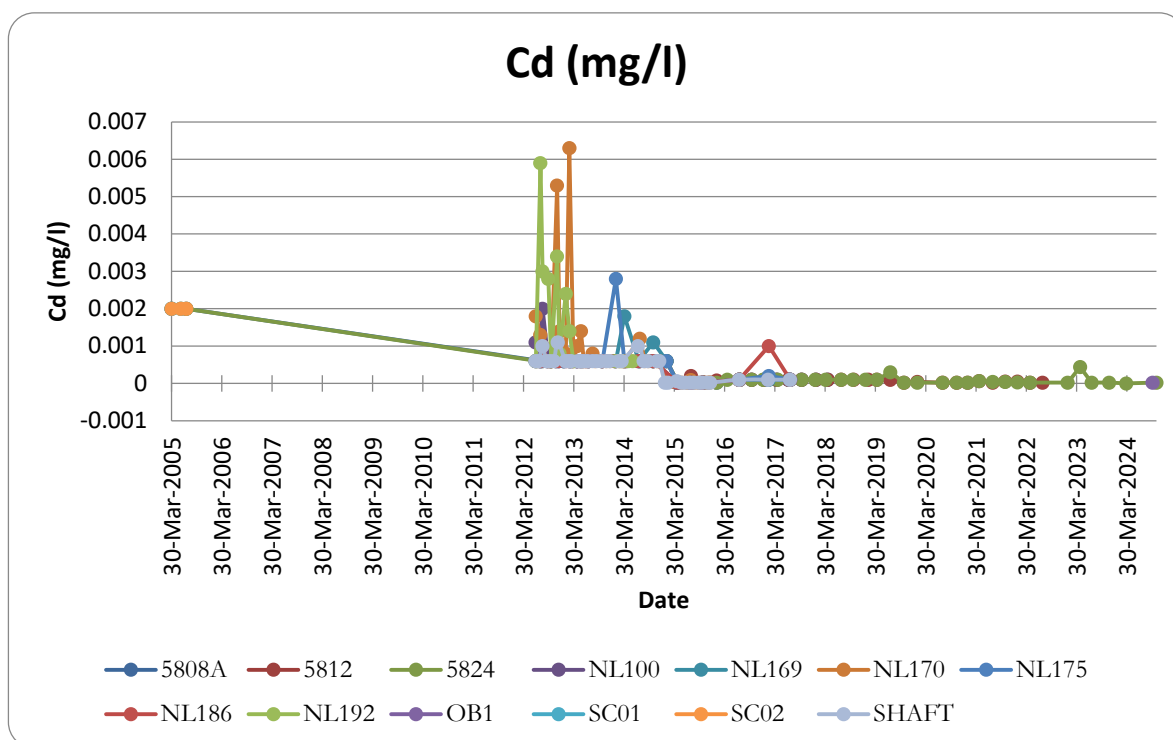


Figure 135: Cd Concentration timeseries within the Groundwater

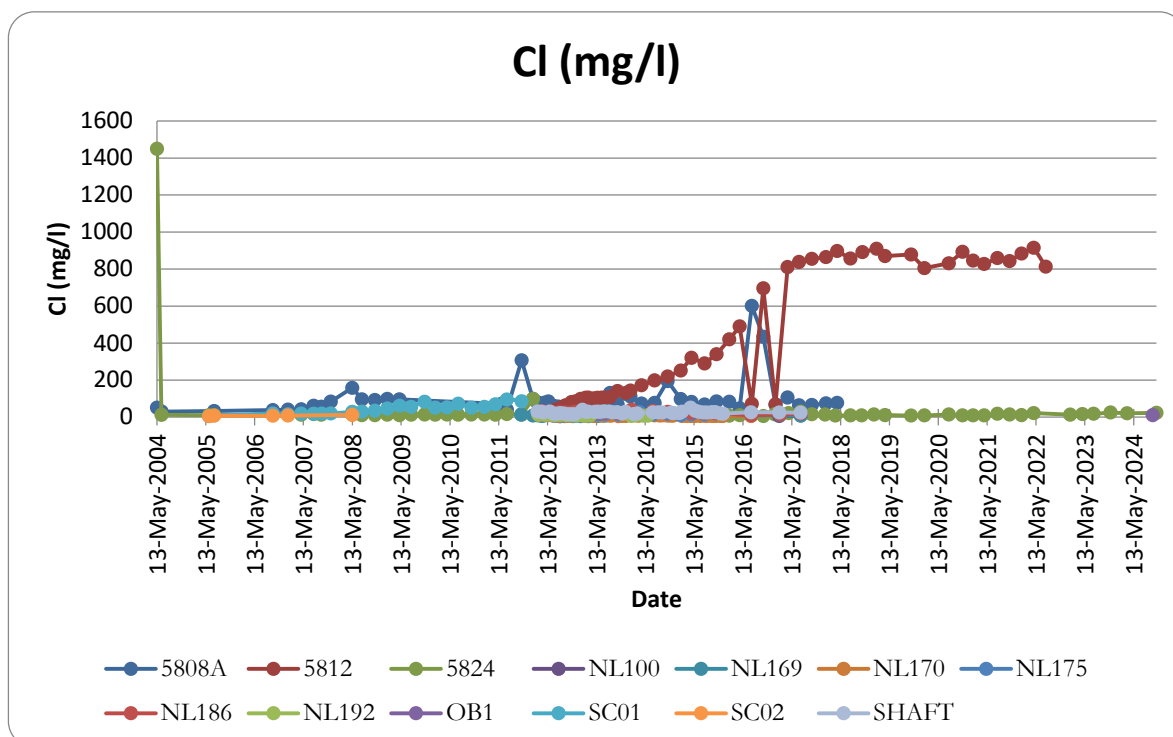


Figure 136: Cl Concentration timeseries within the Groundwater

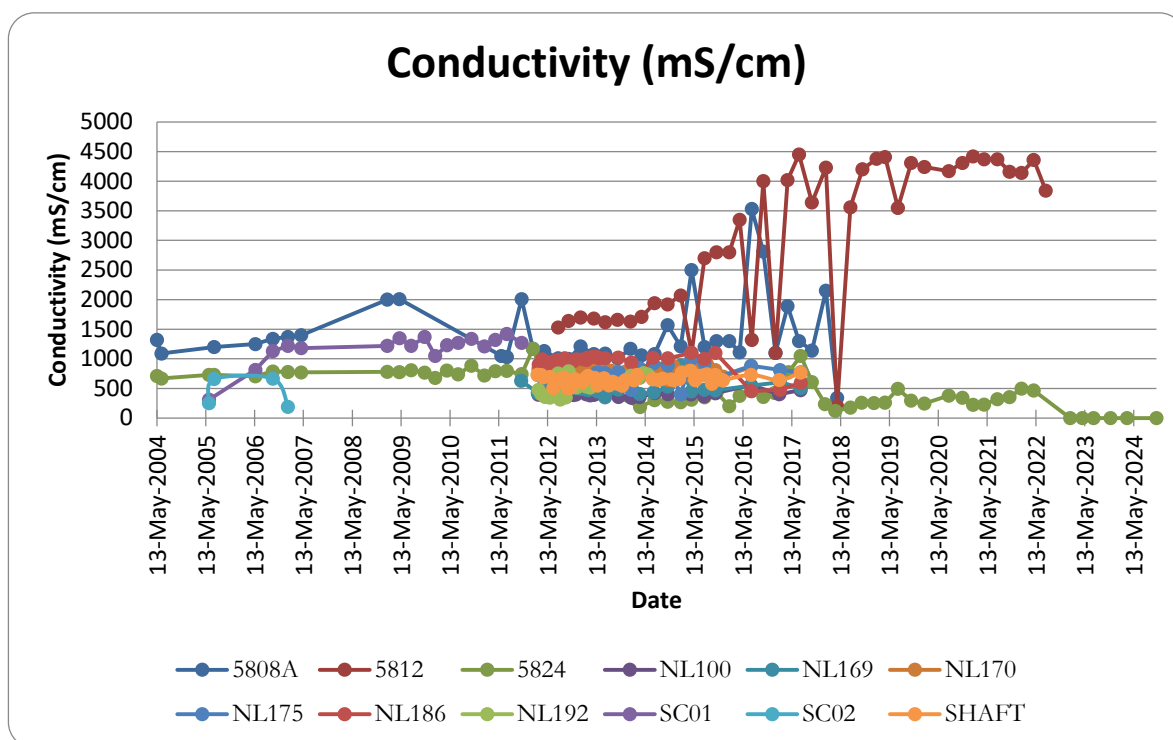


Figure 137: Electrical Conductivity timeseries within the Groundwater

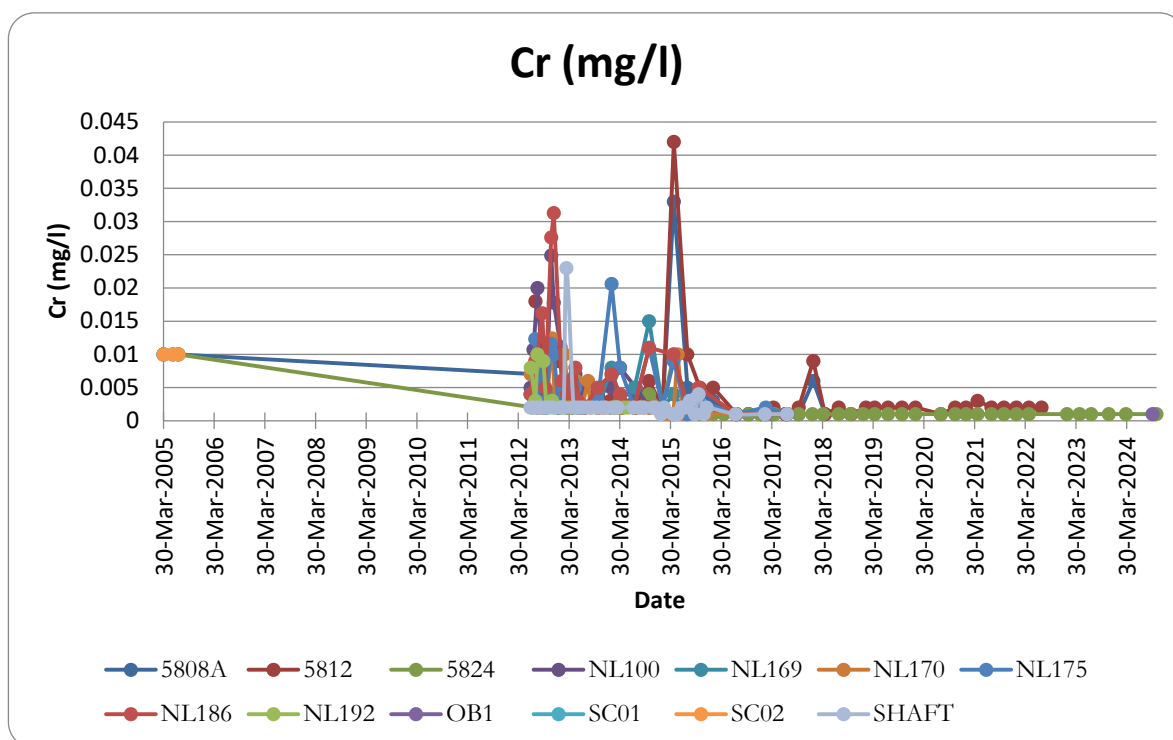


Figure 138: Cr Concentration timeseries within the Groundwater

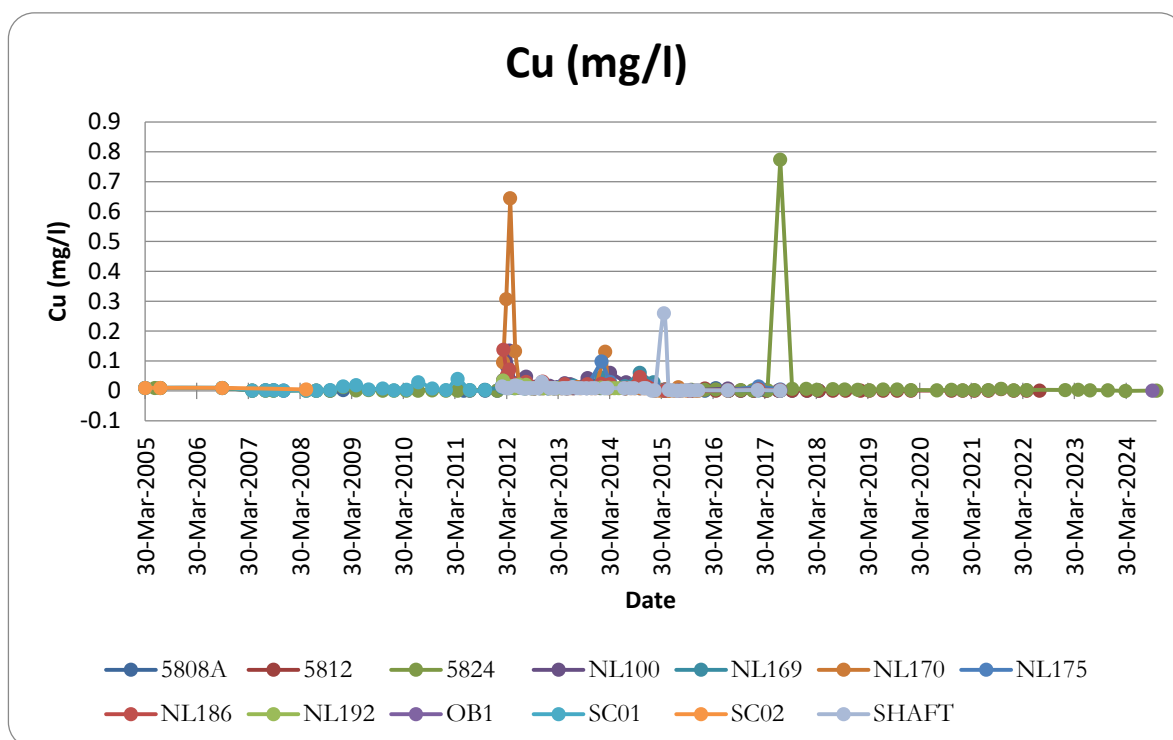


Figure 139: Cu Concentration timeseries within the Groundwater

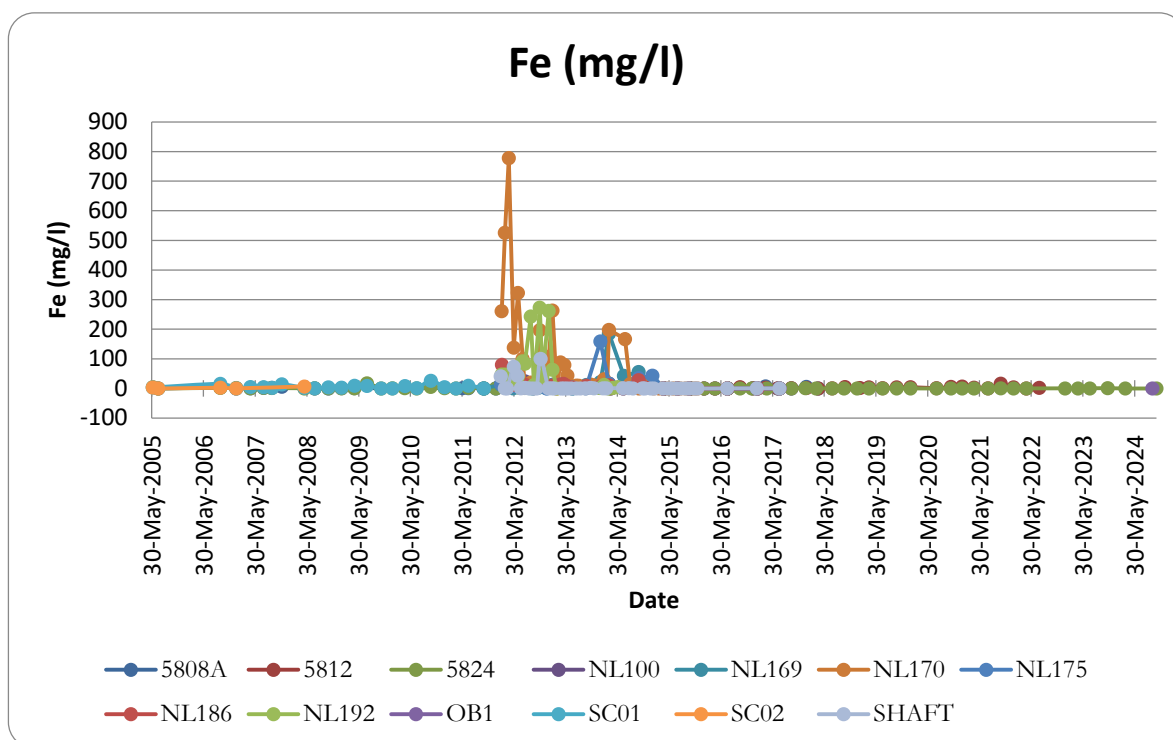


Figure 140: Fe Concentration timeseries within the Groundwater

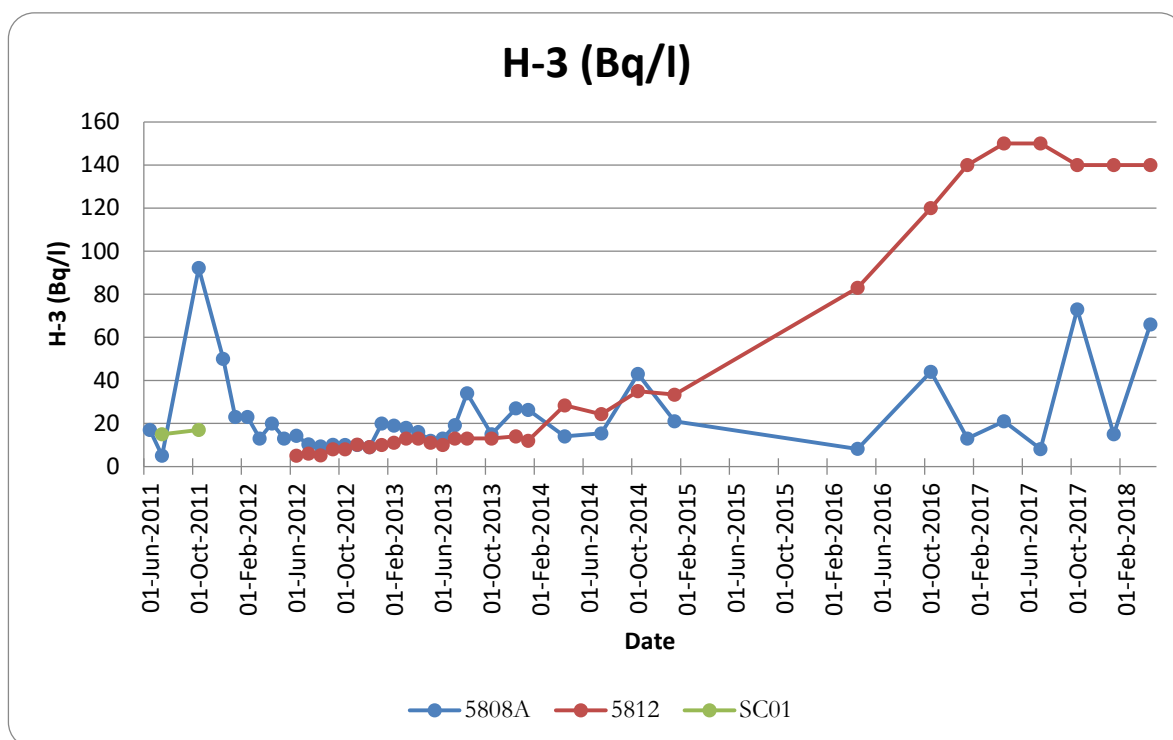


Figure 141: Tritium Concentration timeseries within the Groundwater

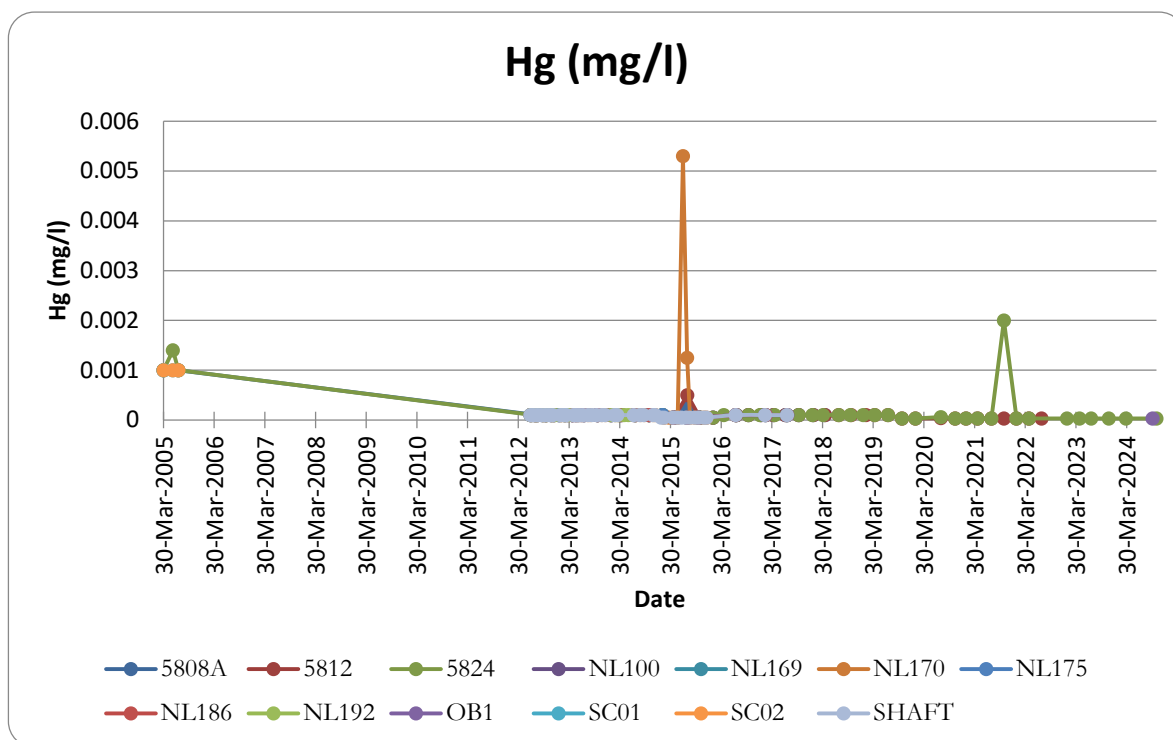


Figure 142: Hg Concentration timeseries within the Groundwater

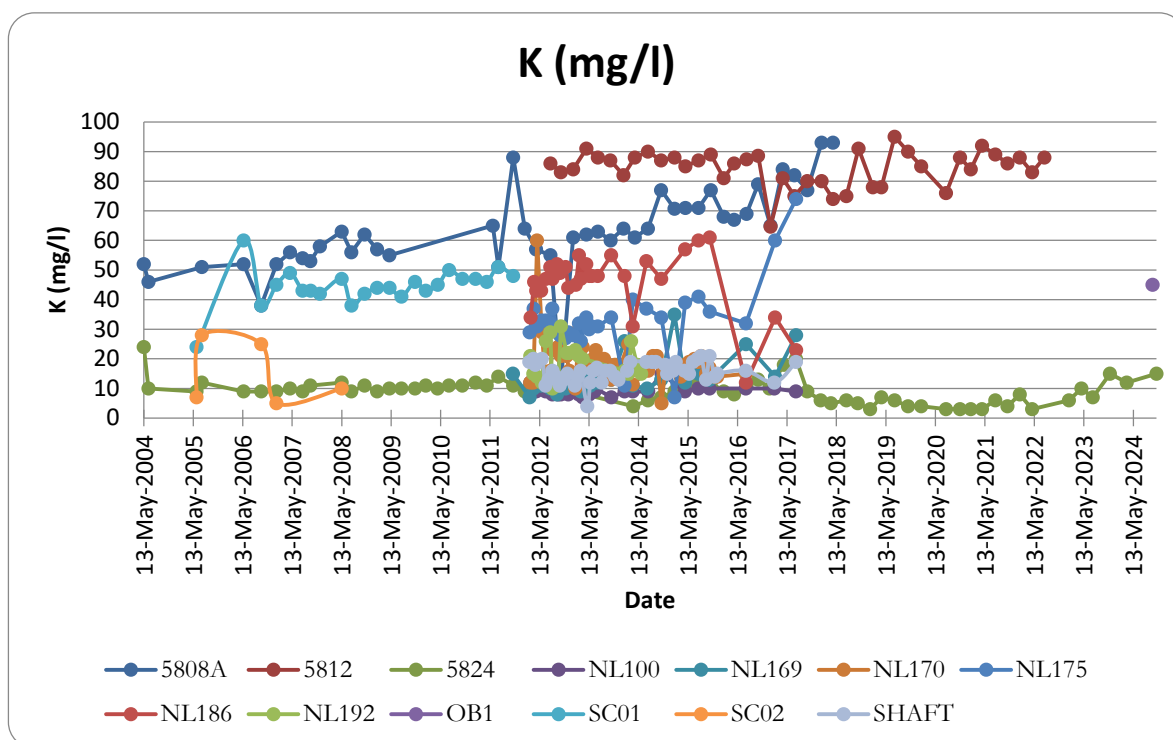


Figure 143: K Concentration timeseries within the Groundwater

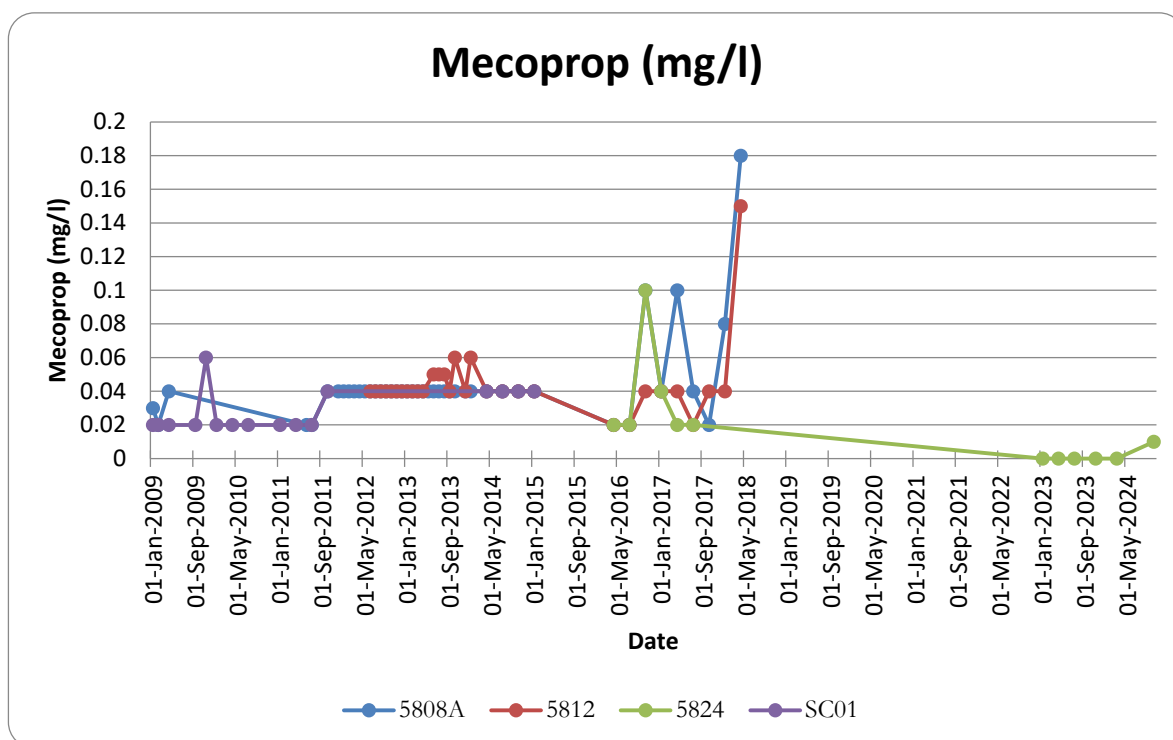


Figure 144: Mecoprop Concentration timeseries within the Groundwater

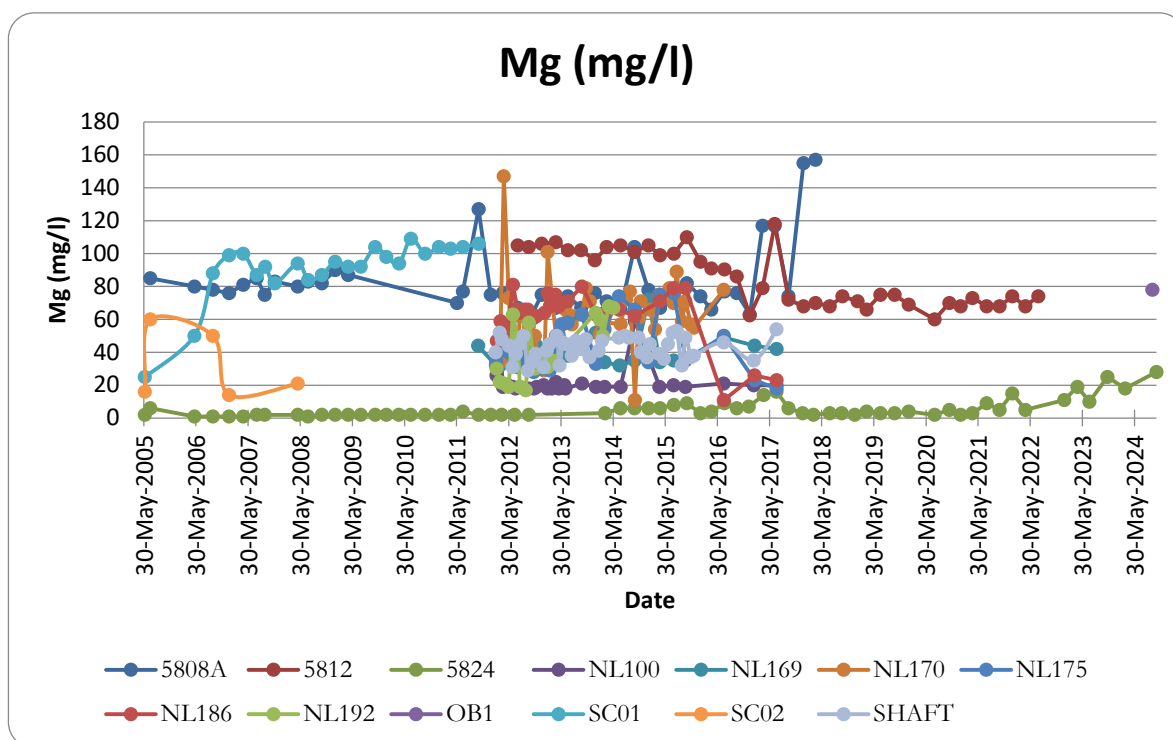


Figure 145: Mg Concentration timeseries within the Groundwater

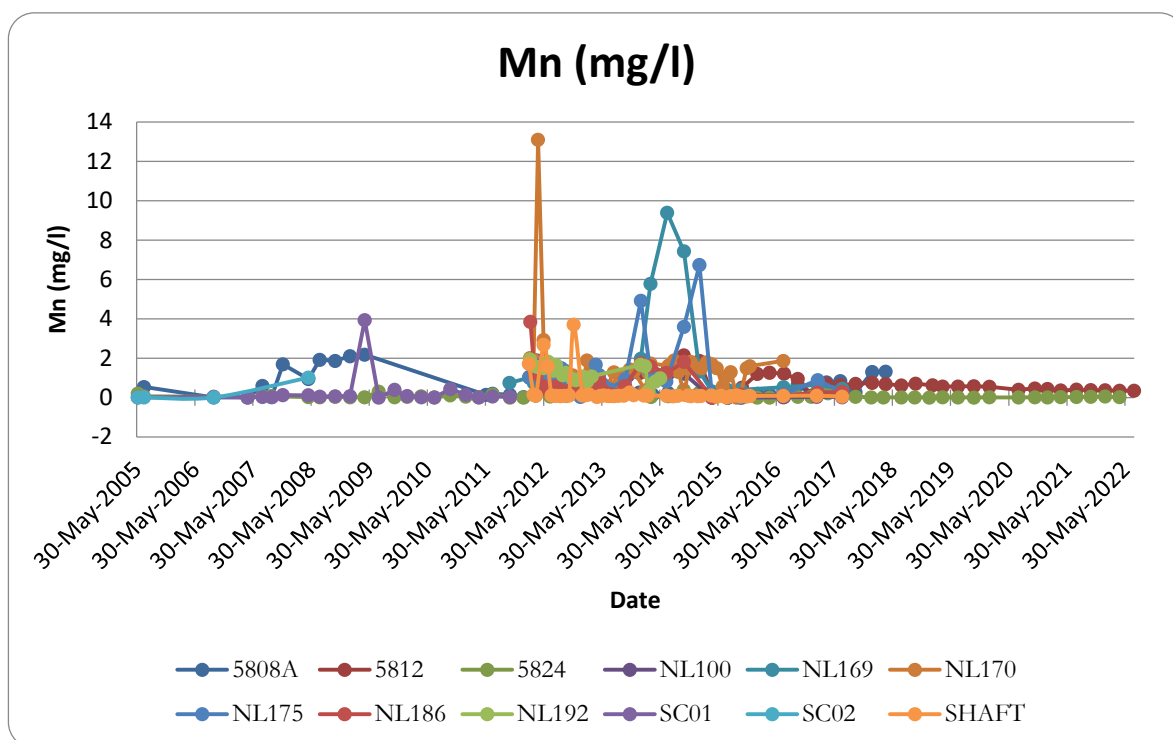


Figure 146: Mn Concentration timeseries within the Groundwater

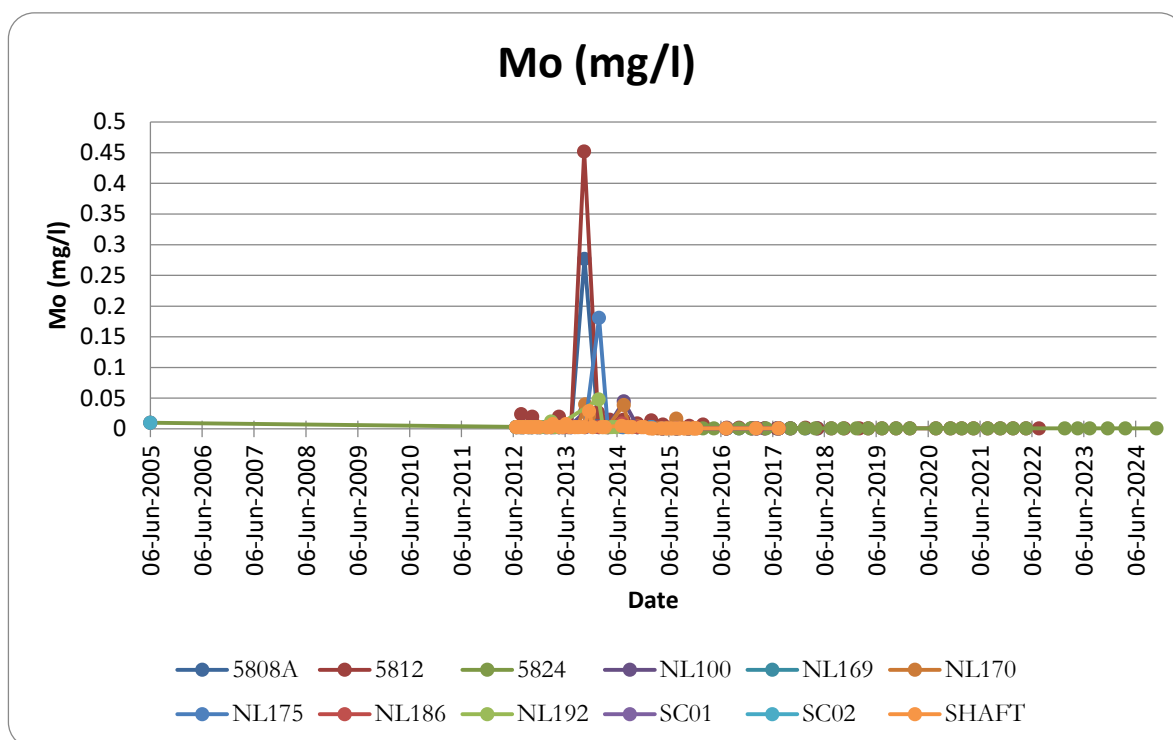


Figure 147: Mo Concentration timeseries within the Groundwater

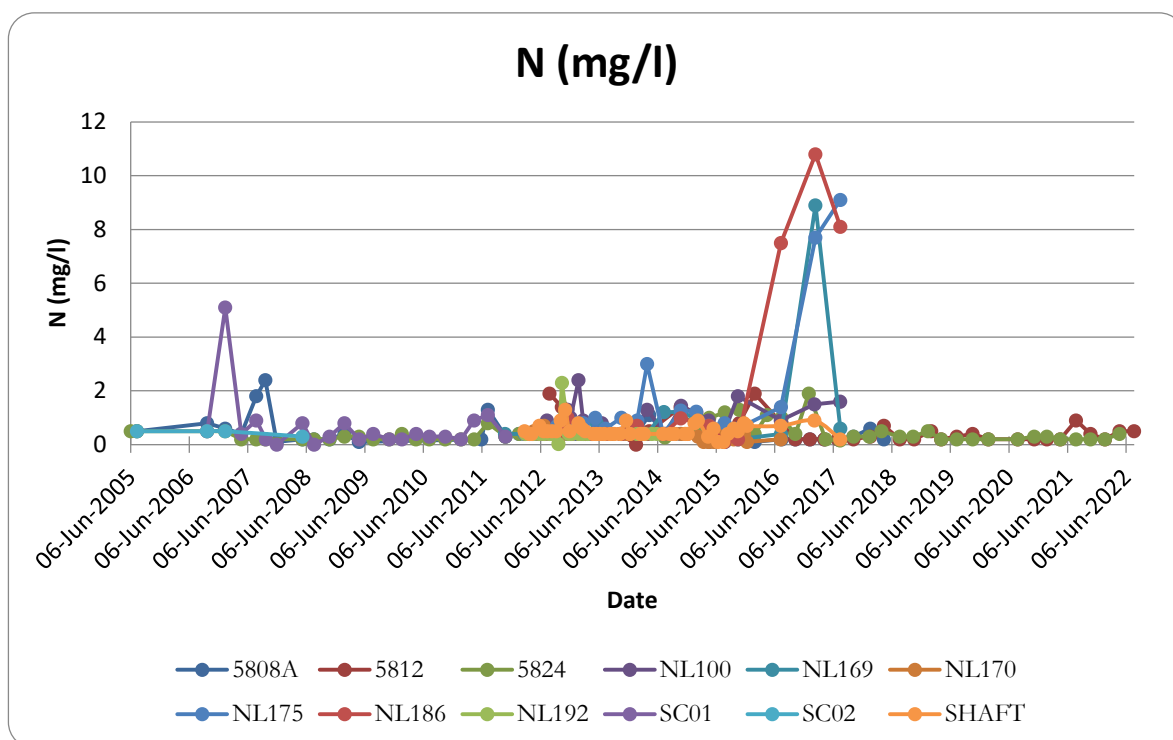


Figure 148: NI Concentration timeseries within the Groundwater

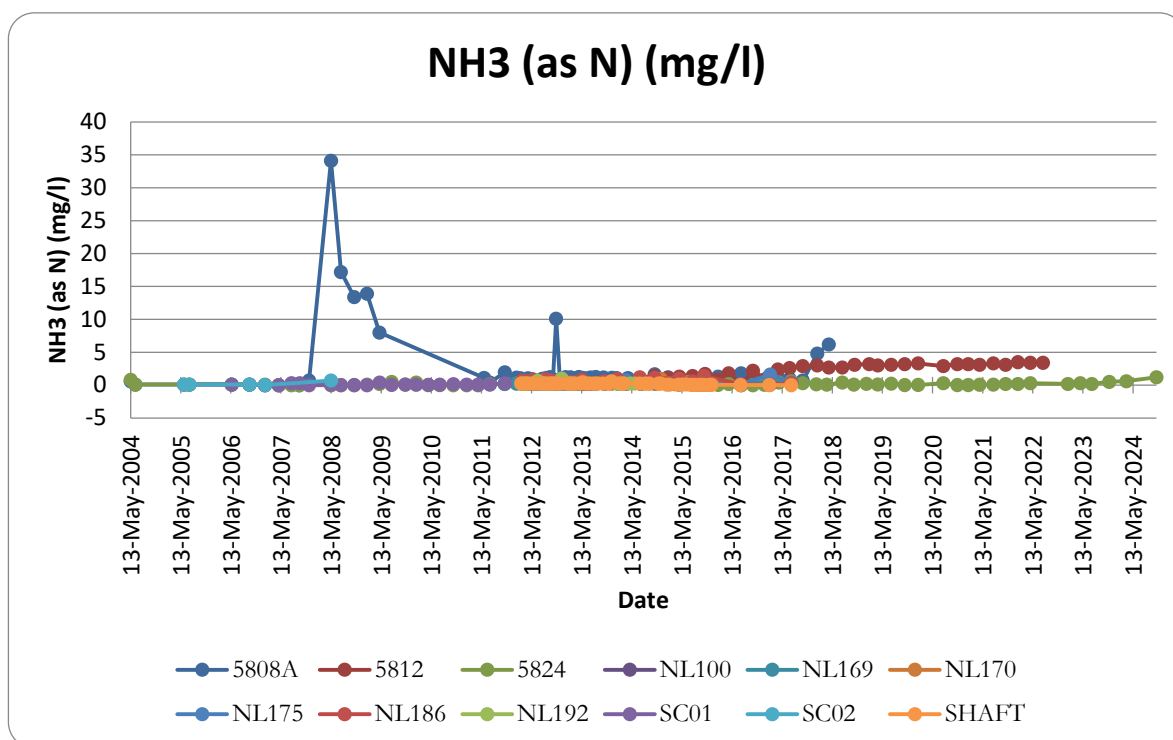


Figure 149: NH3 (as N) Concentration timeseries within the Groundwater

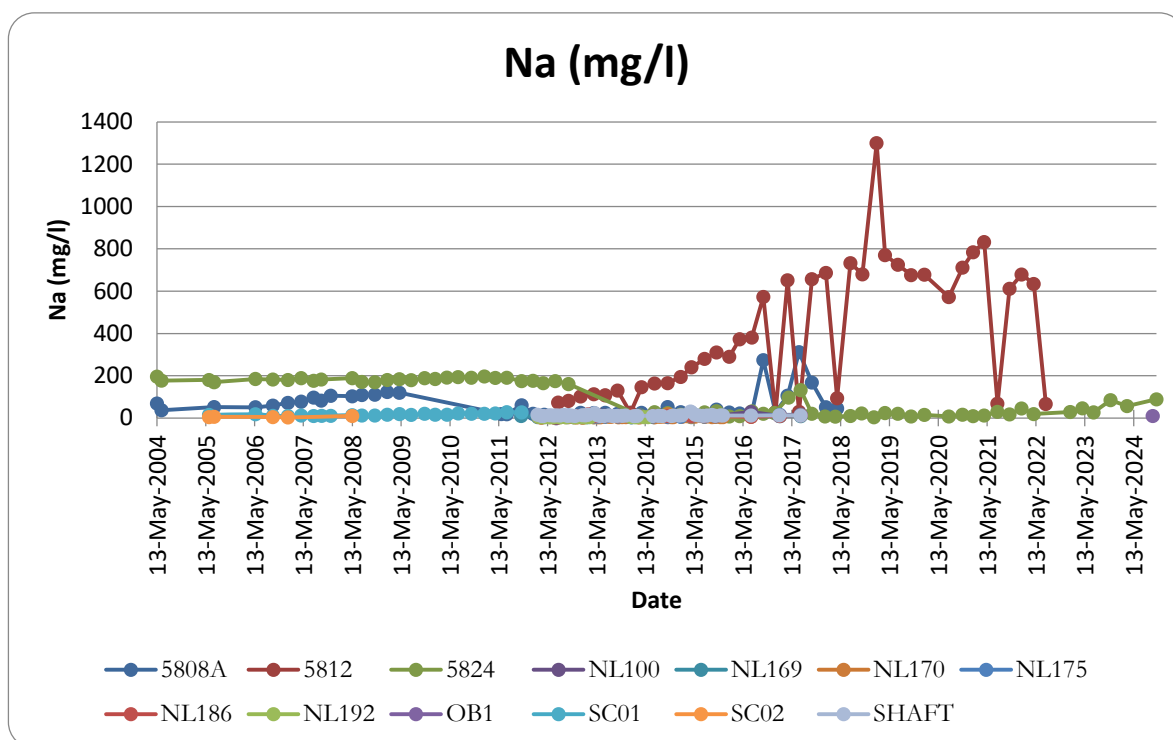


Figure 150: Na Concentration timeseries within the Groundwater

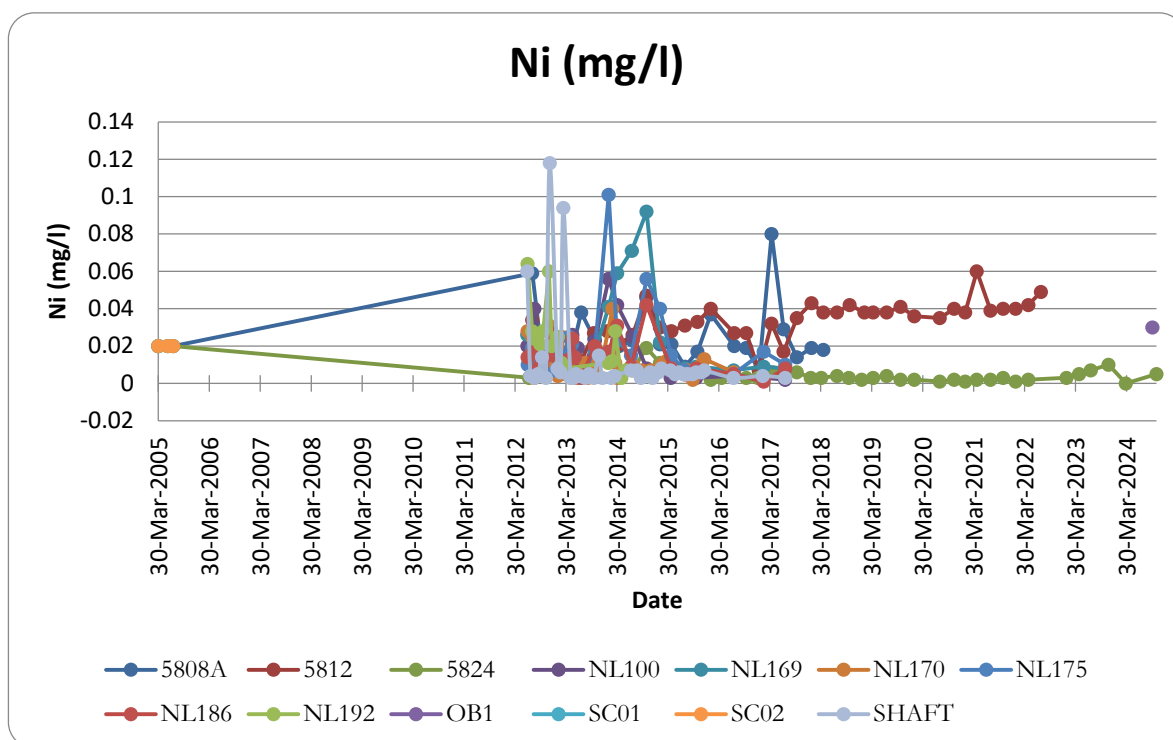


Figure 151: Ni Concentration timeseries within the Groundwater

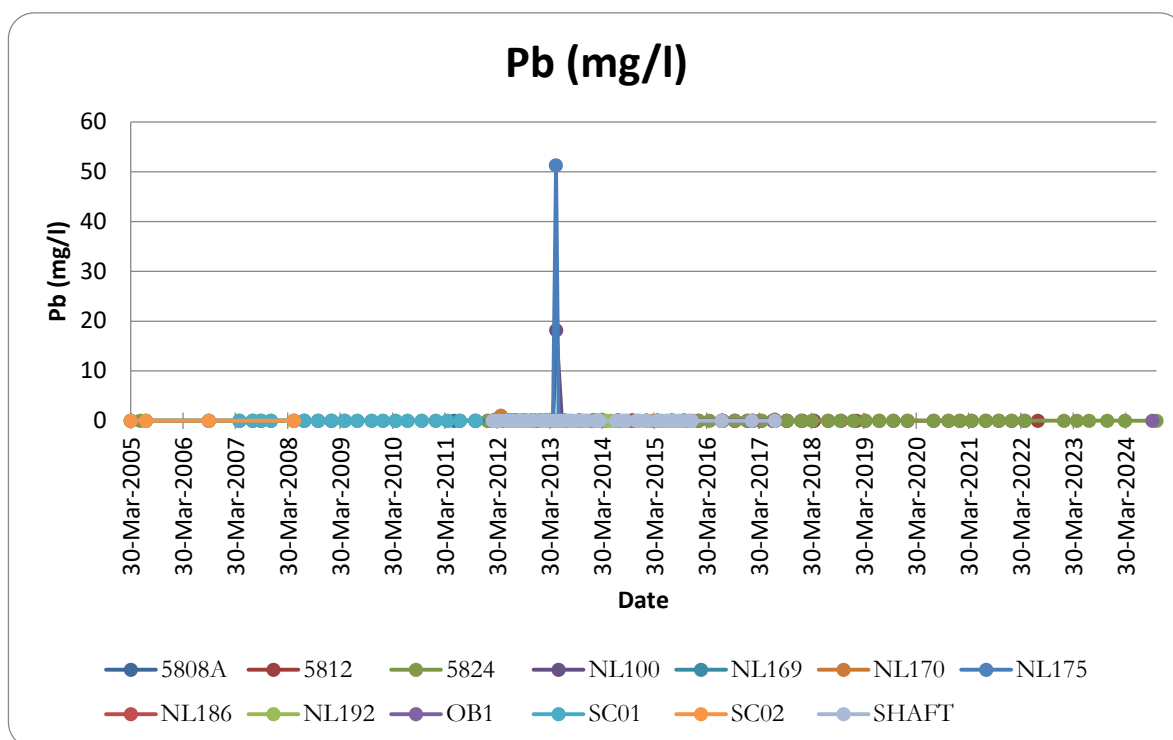


Figure 152: Pb Concentration timeseries within the Groundwater

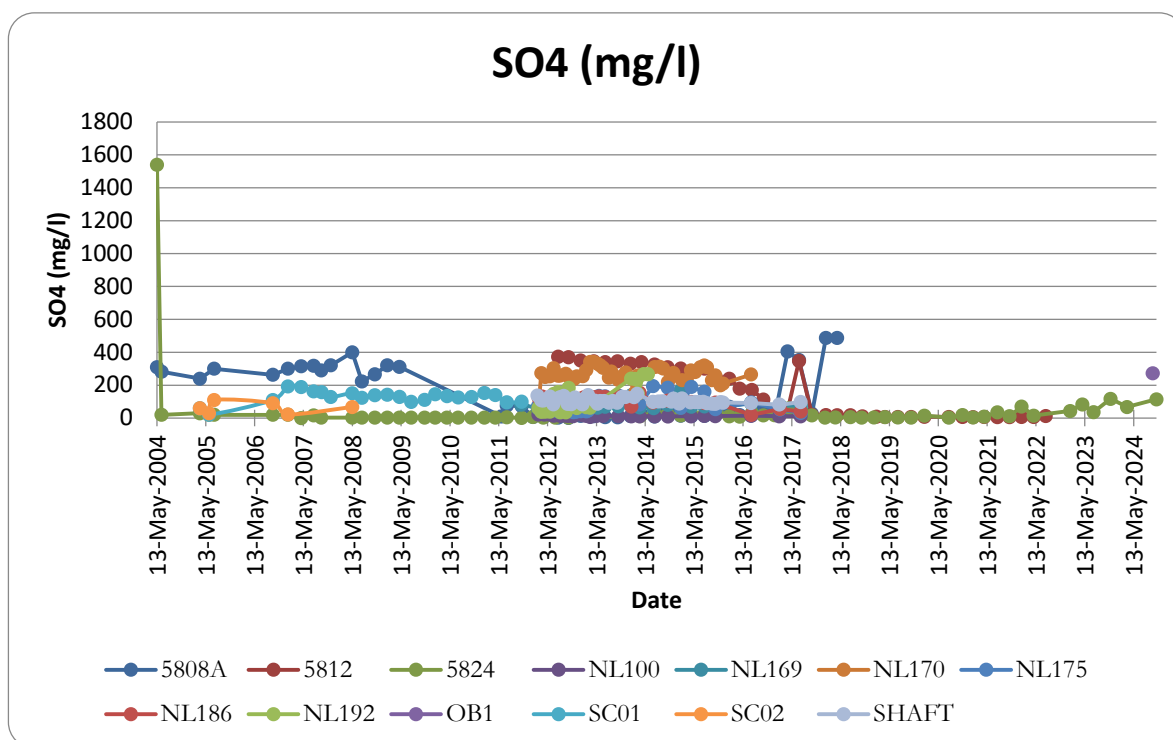
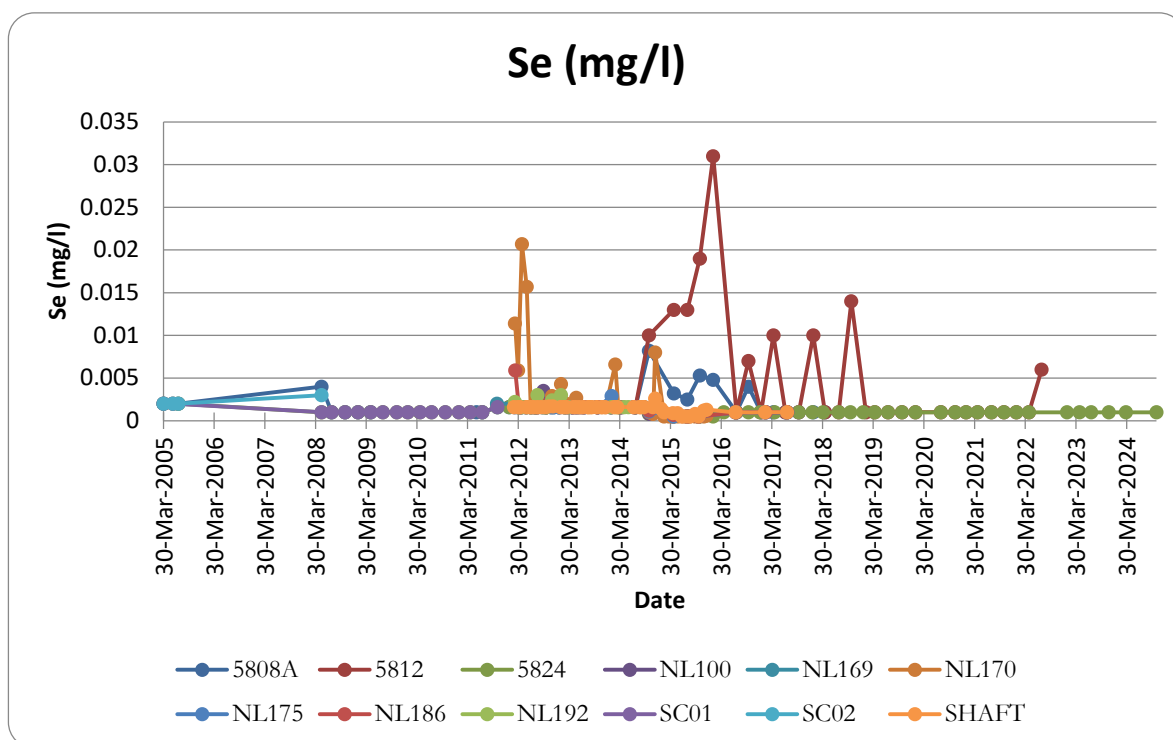
Figure 153: SO<sub>4</sub> Concentration timeseries within the Groundwater

Figure 154: Se Concentration timeseries within the Groundwater

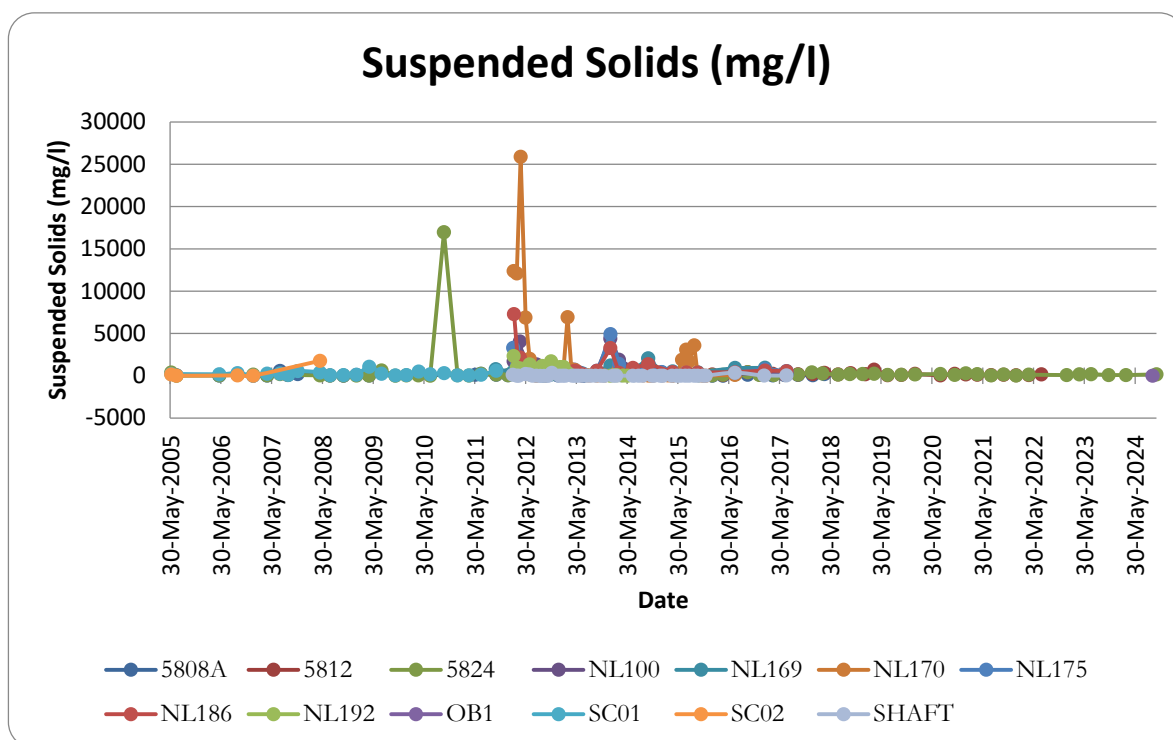


Figure 155: Suspended Solids Concentration timeseries within the Groundwater

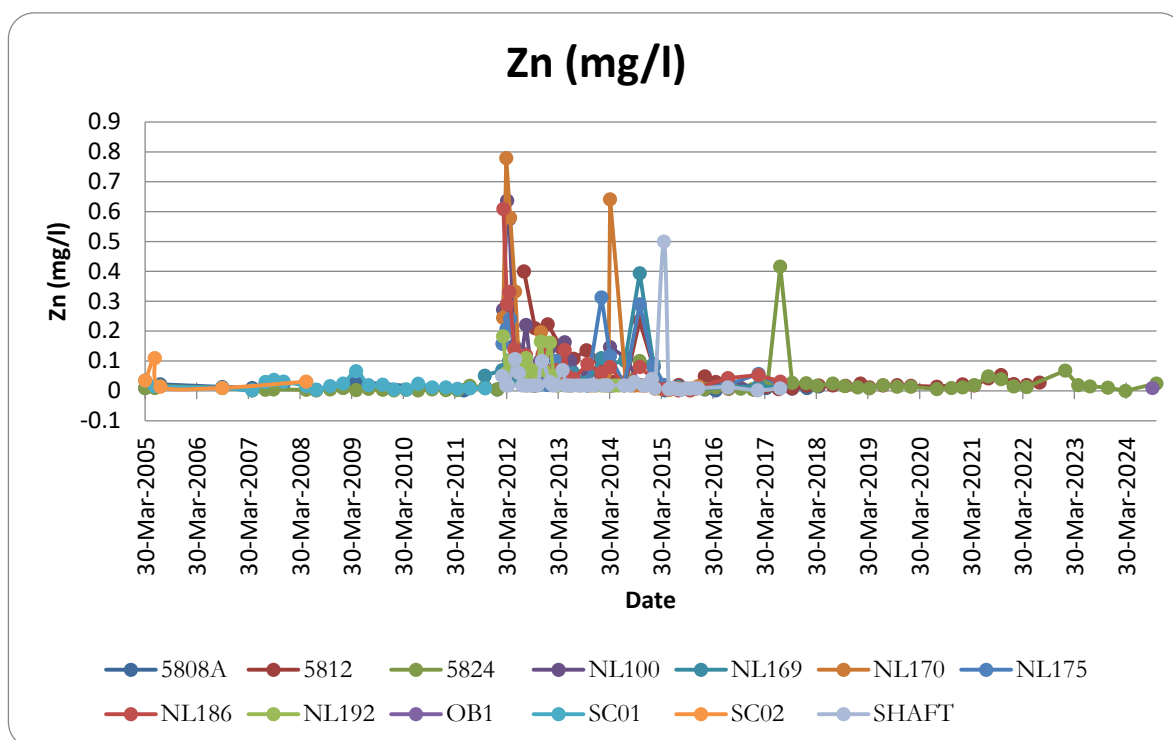


Figure 156: Zn Concentration timeseries within the Groundwater

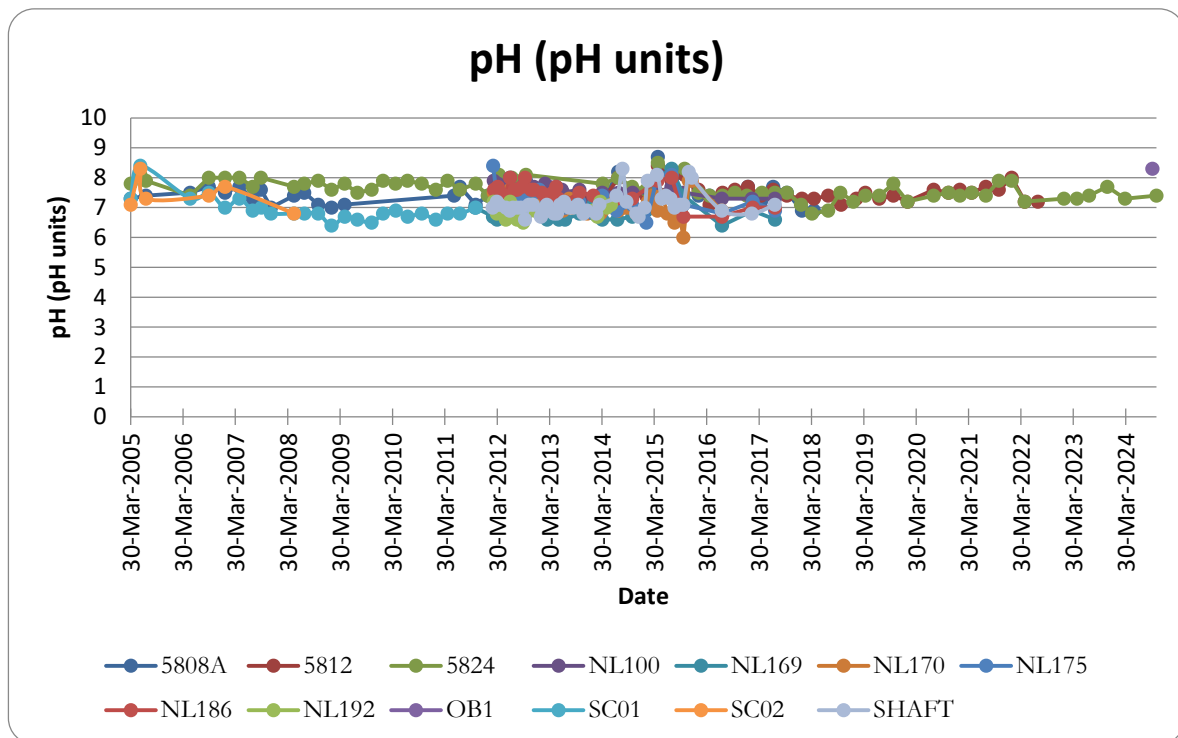


Figure 157: pH Concentration timeseries within the Groundwater

## 10 MINE VOID

Table 12 Mine Void Monitoring Point Statistics

| Parameter    | Units | Stat  | Mine     | Mine - Ground Water | Mine Hole | Mine WB  |
|--------------|-------|-------|----------|---------------------|-----------|----------|
| Al           | mg/l  | min   | 0        | 0.01                | 0.02      | 0.01     |
|              |       | max   | 0.28     | 0.28                | 0.02      | 0.02     |
|              |       | mean  | 0.0739   | 0.077               | 0.02      | 0.0111   |
|              |       | count | 7        | 10                  | 1         | 9        |
| Alkalinity   | mg/l  | min   | 5        | 188                 | 421       | 178      |
|              |       | max   | 311      | 512                 | 421       | 512      |
|              |       | mean  | 228.714  | 338.2               | 421       | 409      |
|              |       | count | 7        | 10                  | 1         | 9        |
| As           | mg/l  | min   | 0.001    | 0.001               | 0.001     | 0.001    |
|              |       | max   | 0.001    | 0.002               | 0.001     | 0.008    |
|              |       | mean  | 0.001    | 0.0011              | 0.001     | 0.00211  |
|              |       | count | 7        | 10                  | 1         | 9        |
| Ca           | mg/l  | min   | 0.01     | 71                  | 151       | 49       |
|              |       | max   | 167      | 177                 | 151       | 177      |
|              |       | mean  | 93.716   | 132                 | 151       | 140.889  |
|              |       | count | 7        | 10                  | 1         | 9        |
| Cd           | mg/l  | min   | 0        | 0.00002             | 0.0001    | 0.00002  |
|              |       | max   | 0.001    | 0.00031             | 0.0001    | 0.0001   |
|              |       | mean  | 0.000183 | 0.000091            | 0.0001    | 6.33E-05 |
|              |       | count | 7        | 10                  | 1         | 9        |
| Cl           | mg/l  | min   | 0.2      | 1                   | 52        | 25       |
|              |       | max   | 73       | 147                 | 52        | 147      |
|              |       | mean  | 36.743   | 50.3                | 52        | 76.222   |
|              |       | count | 7        | 10                  | 1         | 9        |
| Conductivity | mS/cm | min   | 0.00001  | 0.643               | 1880      | 481      |
|              |       | max   | 1.9      | 1.99                | 1880      | 1990     |
|              |       | mean  | 1.1304   | 1.5338              | 1880      | 1620.111 |
|              |       | count | 7        | 10                  | 1         | 9        |
| Cr           | mg/l  | min   | 0.001    | 0.001               | 0.001     | 0.001    |
|              |       | max   | 0.002    | 0.002               | 0.001     | 0.003    |
|              |       | mean  | 0.00129  | 0.0011              | 0.001     | 0.00122  |
|              |       | count | 7        | 10                  | 1         | 9        |
| Cu           | mg/l  | min   | 0        | 0.001               | 0.001     | 0.001    |
|              |       | max   | 0.006    | 0.006               | 0.001     | 0.006    |
|              |       | mean  | 0.0019   | 0.002               | 0.001     | 0.00178  |
|              |       | count | 7        | 10                  | 1         | 9        |
| Fe           | mg/l  | min   | 0        | 0.01                | 0.23      | 0.01     |
|              |       | max   | 131      | 2.36                | 0.23      | 2.7      |
|              |       | mean  | 19.2029  | 0.325               | 0.23      | 0.4389   |
|              |       | count | 7        | 10                  | 1         | 9        |
| H-3          | Bq/l  | min   | 4.4      | 4.3                 | 8.1       |          |
|              |       | max   | 4.4      | 10.4                | 8.1       |          |
|              |       | mean  | 4.4      | 5.8                 | 8.1       |          |
|              |       | count | 1        | 7                   | 1         |          |
| Hg           | mg/l  | min   | 0.00003  | 0.00003             | 0.0001    | 0.00003  |
|              |       | max   | 0.063    | 0.00003             | 0.0001    | 0.0001   |
|              |       | mean  | 0.009026 | 0.00003             | 0.0001    | 4.56E-05 |
|              |       | count | 7        | 10                  | 1         | 9        |
| K            | mg/l  | min   | 17       | 17                  | 81        | 7        |
|              |       | max   | 108      | 78                  | 81        | 80       |
|              |       | mean  | 57.143   | 51.8                | 81        | 62.667   |



| Parameter        | Units    | Stat  | Mine    | Mine - Ground Water | Mine Hole | Mine WB |
|------------------|----------|-------|---------|---------------------|-----------|---------|
| Mecoprop         | mg/l     | count | 7       | 10                  | 1         | 9       |
|                  |          | min   | 0       | 0.00002             | 0.04      |         |
|                  |          | max   | 0.01    | 0.01                | 0.04      |         |
|                  |          | mean  | 0.0017  | 0.0011              | 0.04      |         |
|                  |          | count | 6       | 9                   | 1         |         |
| Mg               | mg/l     | min   | 0.03    | 28                  | 151       | 11      |
|                  |          | max   | 128     | 148                 | 151       | 148     |
|                  |          | mean  | 75.719  | 106.6               | 151       | 109.889 |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Mn               | mg/l     | min   | 0.001   | 0.063               | 1.025     | 0.054   |
|                  |          | max   | 1.23    | 1.08                | 1.025     | 1.2     |
|                  |          | mean  | 0.33    | 0.47                | 1.025     | 0.771   |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Mo               | mg/l     | min   | 0       | 0.001               | 0.001     | 0.001   |
|                  |          | max   | 0.003   | 0.003               | 0.001     | 0.005   |
|                  |          | mean  | 0.00143 | 0.0016              | 0.001     | 0.00222 |
|                  |          | count | 7       | 10                  | 1         | 9       |
| N                | mg/l     | min   |         |                     | 0.3       | 0.2     |
|                  |          | max   |         |                     | 0.3       | 1.6     |
|                  |          | mean  |         |                     | 0.3       | 0.733   |
|                  |          | count |         |                     | 1         | 9       |
| NH3 (as N)       | mg/l     | min   | 0.2     | 0.04                | 1.7       | 0.04    |
|                  |          | max   | 1.7     | 2.1                 | 1.7       | 2.1     |
|                  |          | mean  | 1.229   | 1.164               | 1.7       | 1.38    |
|                  |          | count | 7       | 10                  | 1         | 8       |
| Na               | mg/l     | min   | 22      | 14                  | 35        | 34      |
|                  |          | max   | 95      | 95                  | 35        | 75      |
|                  |          | mean  | 37.14   | 41.2                | 35        | 48.11   |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Ni               | mg/l     | min   | 0.001   | 0.006               | 0.024     | 0.006   |
|                  |          | max   | 0.352   | 0.188               | 0.024     | 0.111   |
|                  |          | mean  | 0.12186 | 0.0832              | 0.024     | 0.05067 |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Pb               | mg/l     | min   | 0.0002  | 0.0002              | 0.001     | 0.001   |
|                  |          | max   | 0.002   | 0.002               | 0.001     | 0.001   |
|                  |          | mean  | 0.00103 | 0.00102             | 0.001     | 0.001   |
|                  |          | count | 7       | 10                  | 1         | 9       |
| SO4              | mg/l     | min   | 17      | 138                 | 579       | 7       |
|                  |          | max   | 714     | 713                 | 579       | 677     |
|                  |          | mean  | 382.571 | 495.3               | 579       | 359.444 |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Se               | mg/l     | min   | 0       | 0.001               | 0.001     | 0.001   |
|                  |          | max   | 0.006   | 0.006               | 0.001     | 0.004   |
|                  |          | mean  | 0.00414 | 0.0032              | 0.001     | 0.00178 |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Suspended Solids | mg/l     | min   | 2.28    | 5                   | 115       | 5       |
|                  |          | max   | 5       | 112                 | 115       | 509     |
|                  |          | mean  | 4.611   | 23.3                | 115       | 90      |
|                  |          | count | 7       | 10                  | 1         | 9       |
| Zn               | mg/l     | min   | 0       | 0.007               | 0.01      | 0.011   |
|                  |          | max   | 0.069   | 0.034               | 0.01      | 0.051   |
|                  |          | mean  | 0.02043 | 0.0185              | 0.01      | 0.02422 |
|                  |          | count | 7       | 10                  | 1         | 9       |
| pH               | pH units | min   | 7.2     | 7.9                 | 7.9       | 7       |
|                  |          | max   | 787     | 8.2                 | 7.9       | 8.2     |
|                  |          | mean  | 119.257 | 8.07                | 7.9       | 7.722   |



| Parameter | Units | Stat  | Mine | Mine - Ground<br>Water | Mine<br>Hole | Mine WB |
|-----------|-------|-------|------|------------------------|--------------|---------|
|           |       | count | 7    | 10                     | 1            | 9       |

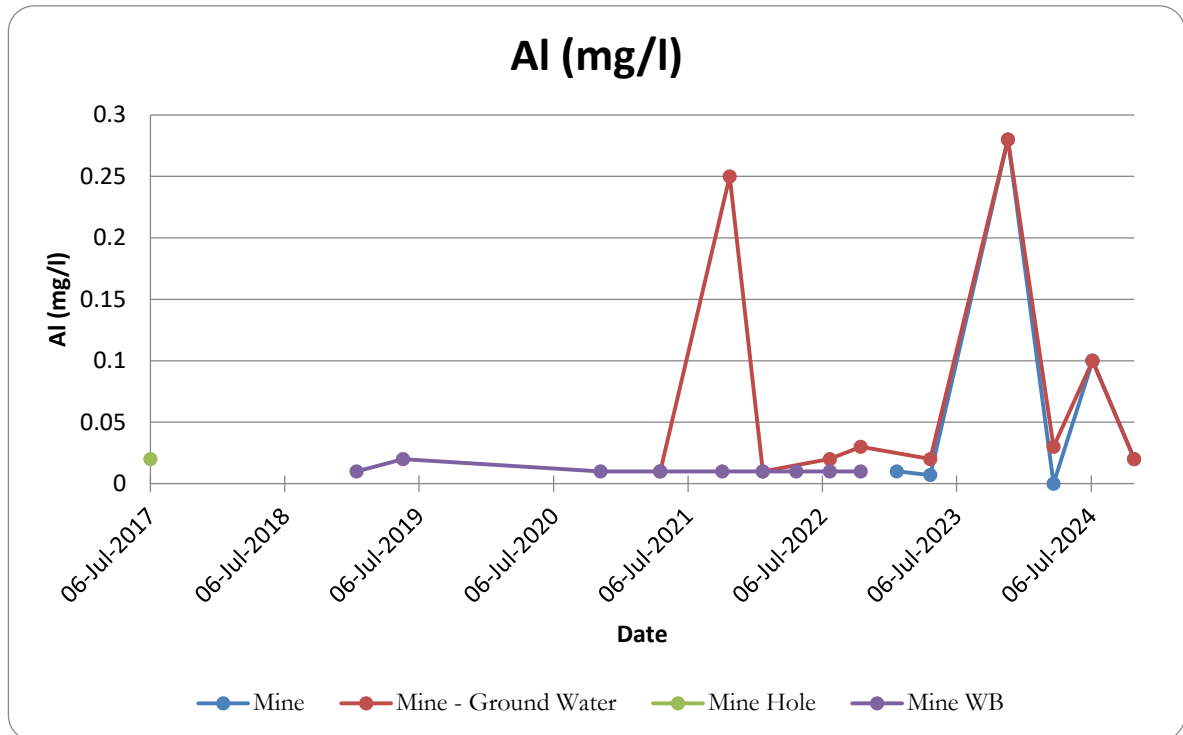


Figure 158: Al Concentration timeseries within the Mine Void

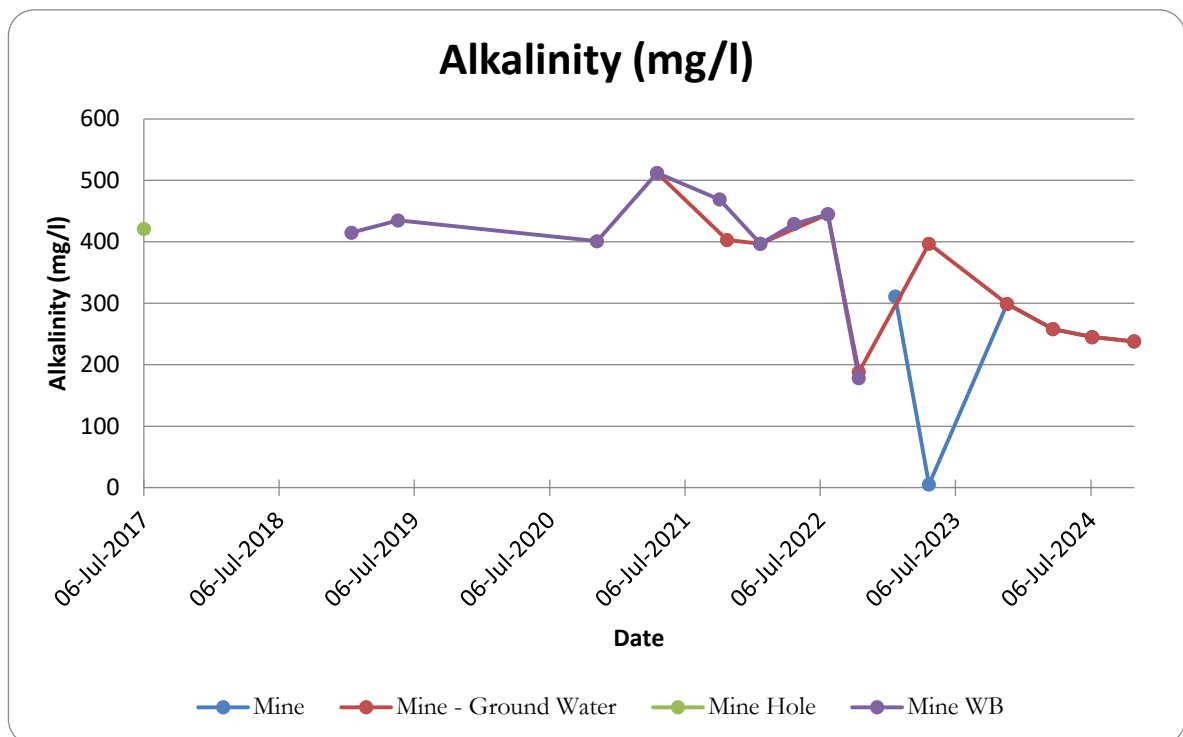


Figure 159: Alkalinity Concentration timeseries within the Mine Void

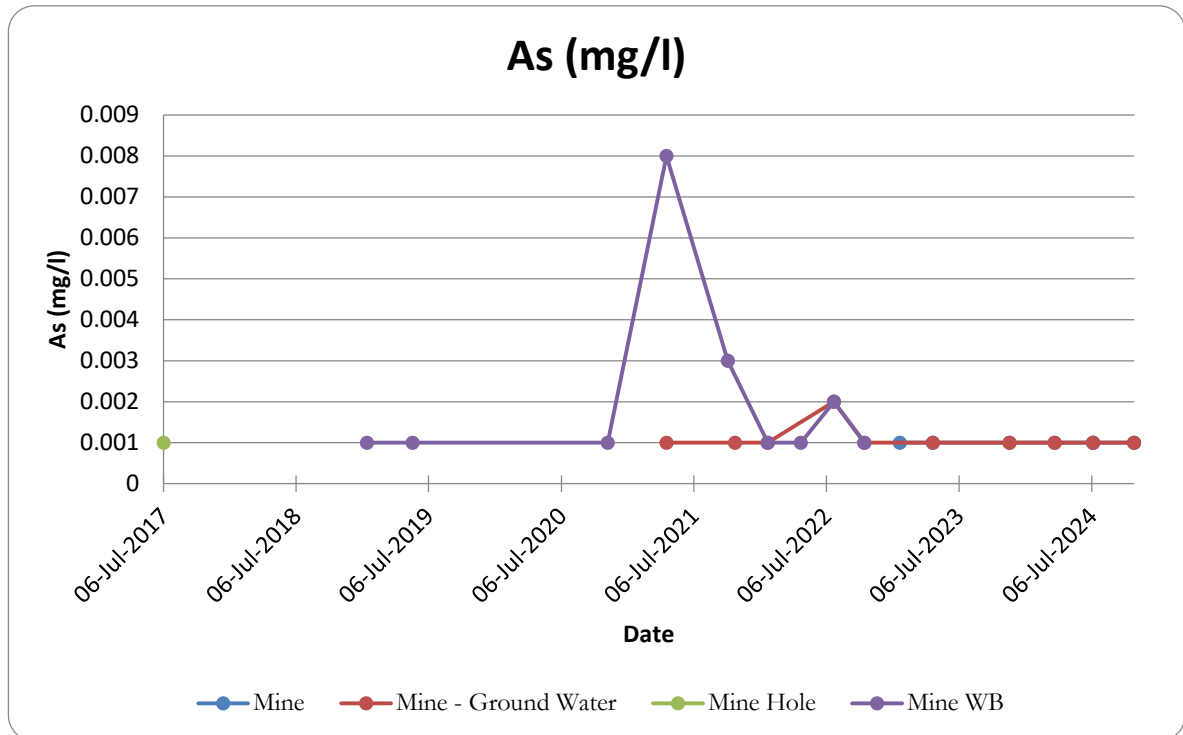


Figure 160: As Concentration timeseries within the Mine Void

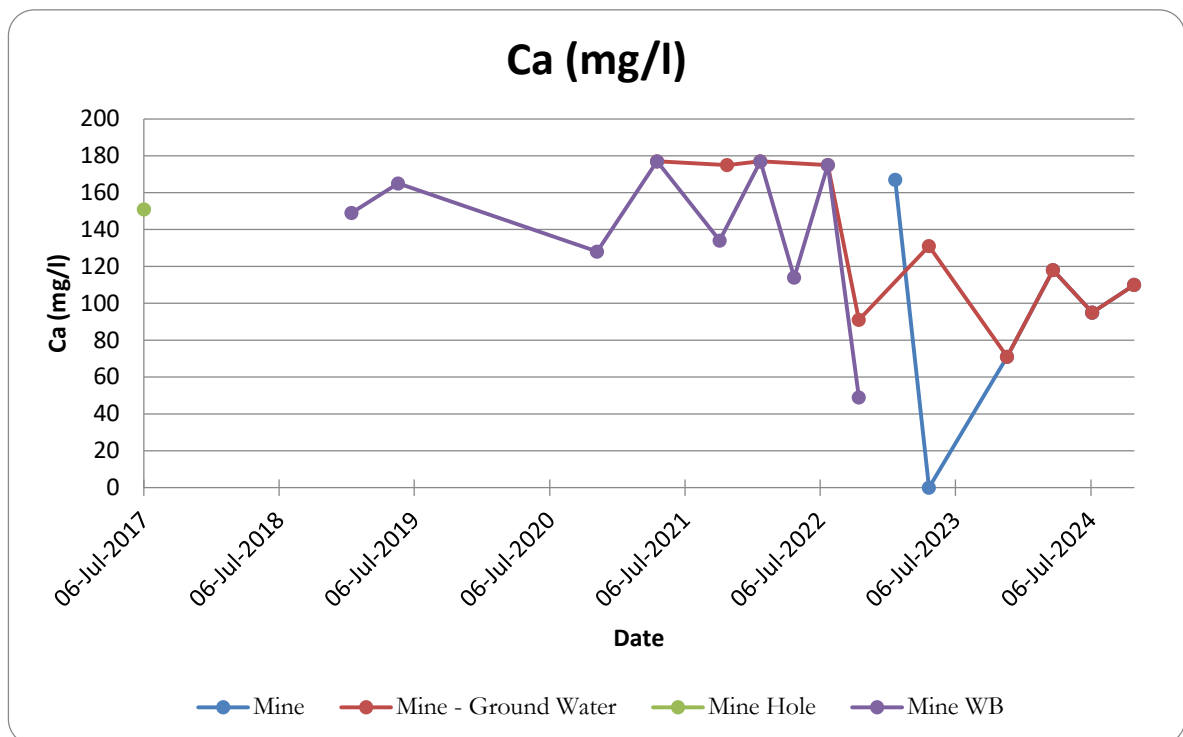


Figure 161: Ca Concentration timeseries within the Mine Void

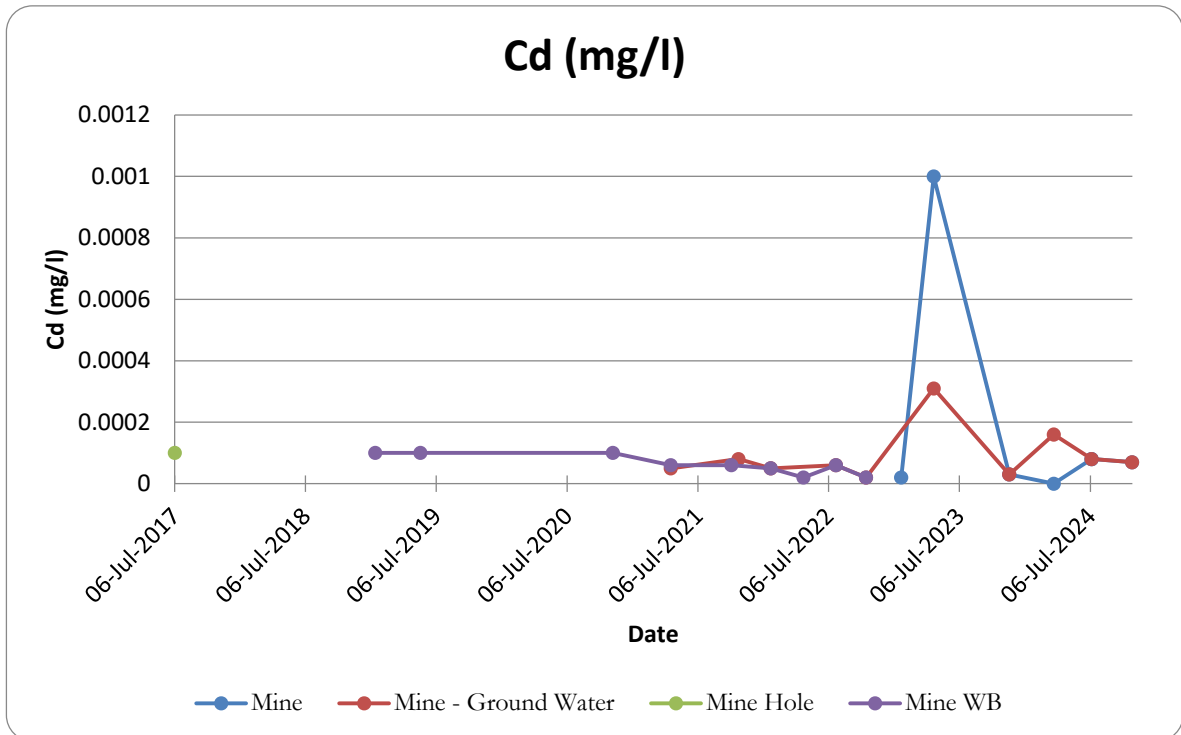


Figure 162: Cd Concentration timeseries within the Mine Void

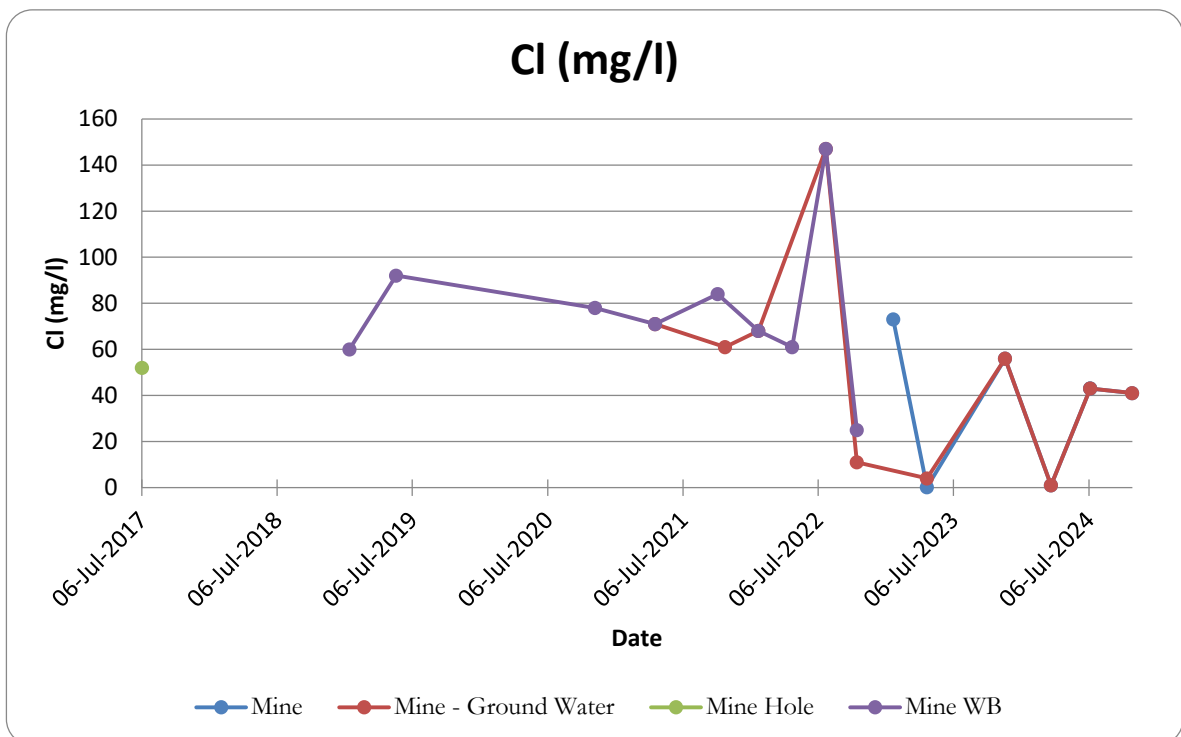


Figure 163: Cl Concentration timeseries within the Mine Void

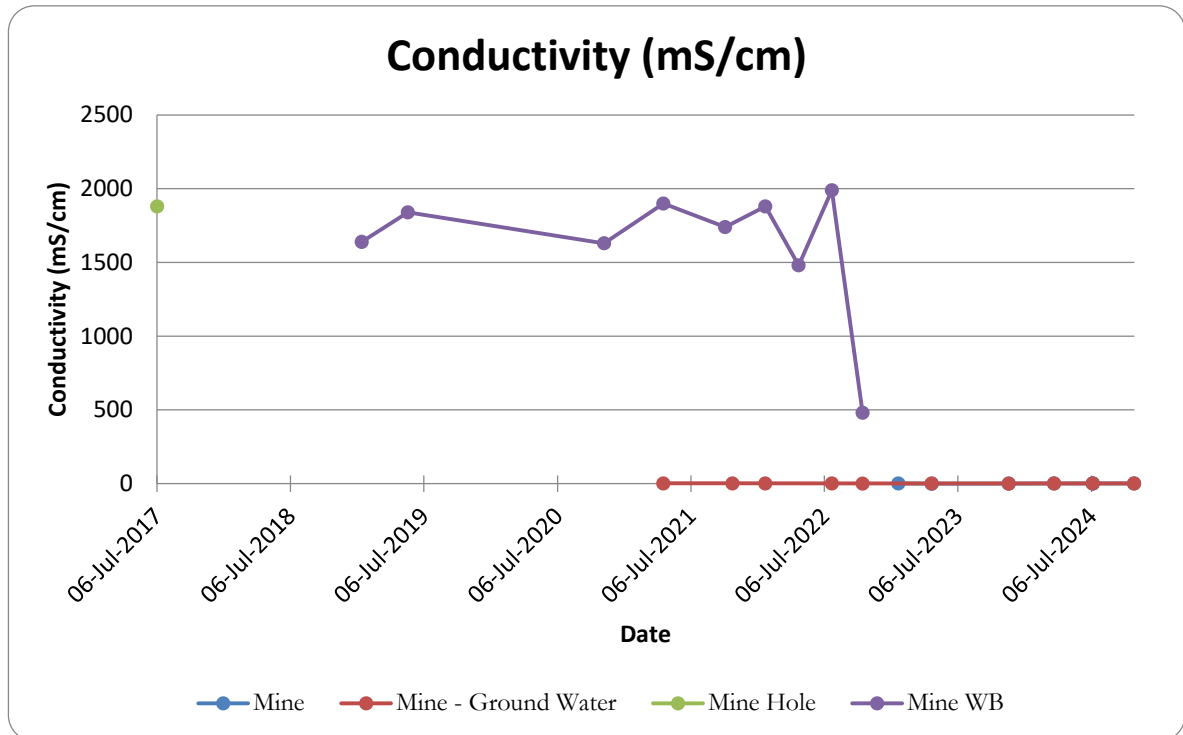


Figure 164: Electrical Conductivity timeseries within the Mine Void

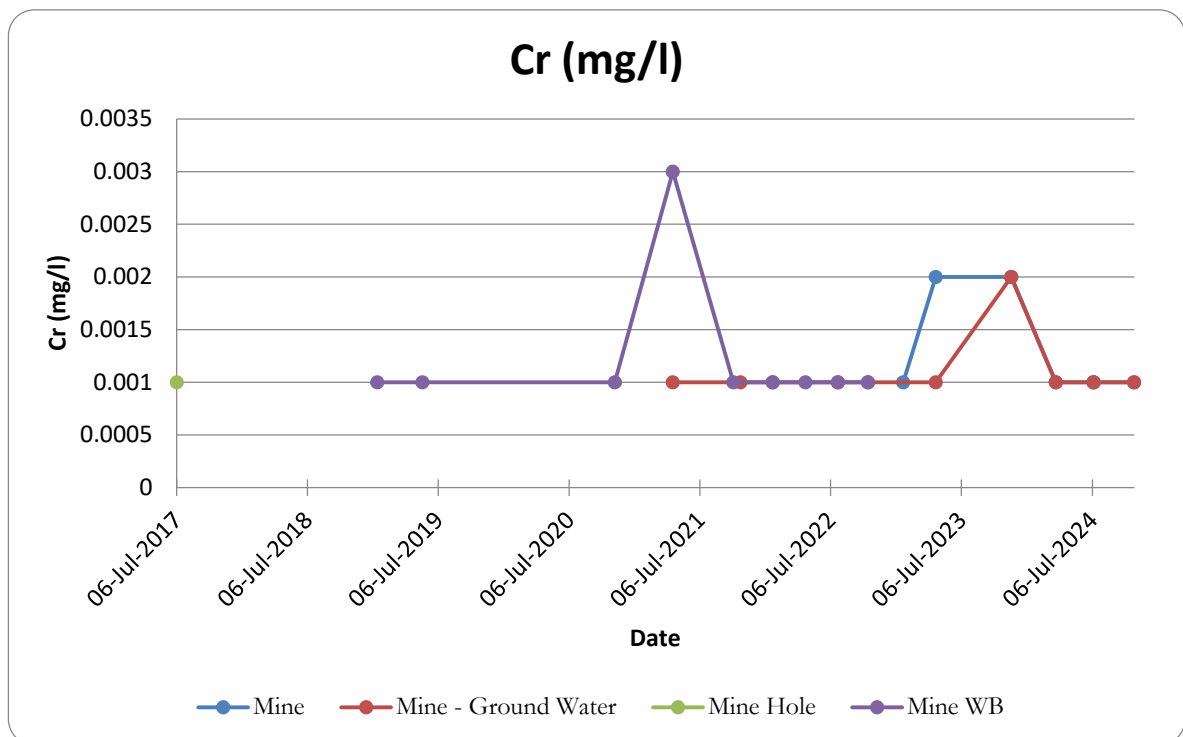


Figure 165:Cr Concentration timeseries within the Mine Void

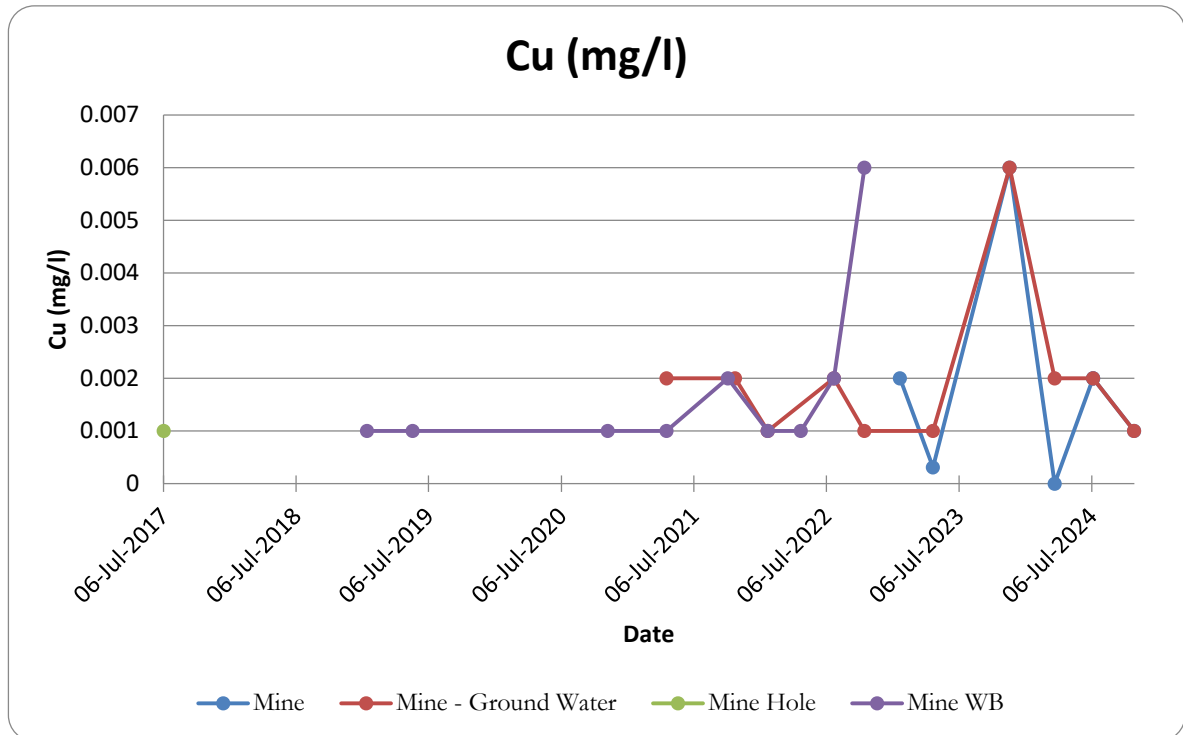


Figure 166: Cu Concentration timeseries within the Mine Void

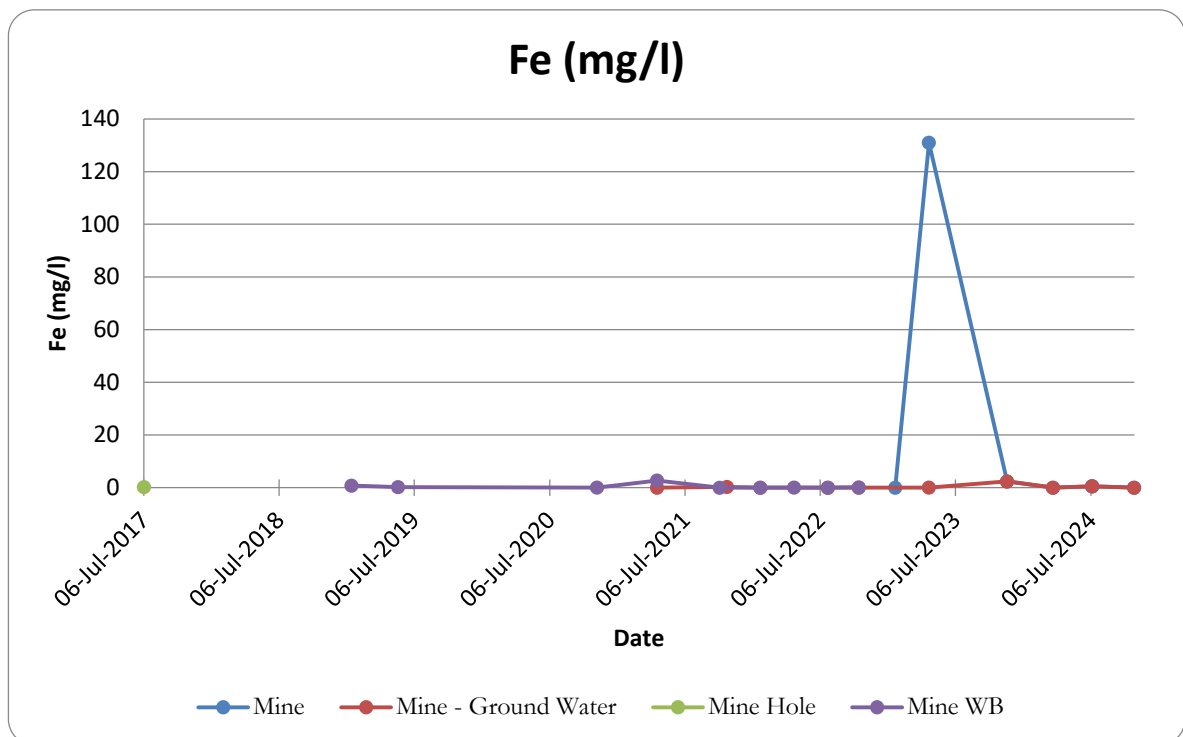


Figure 167: Fe Concentration timeseries within the Mine Void

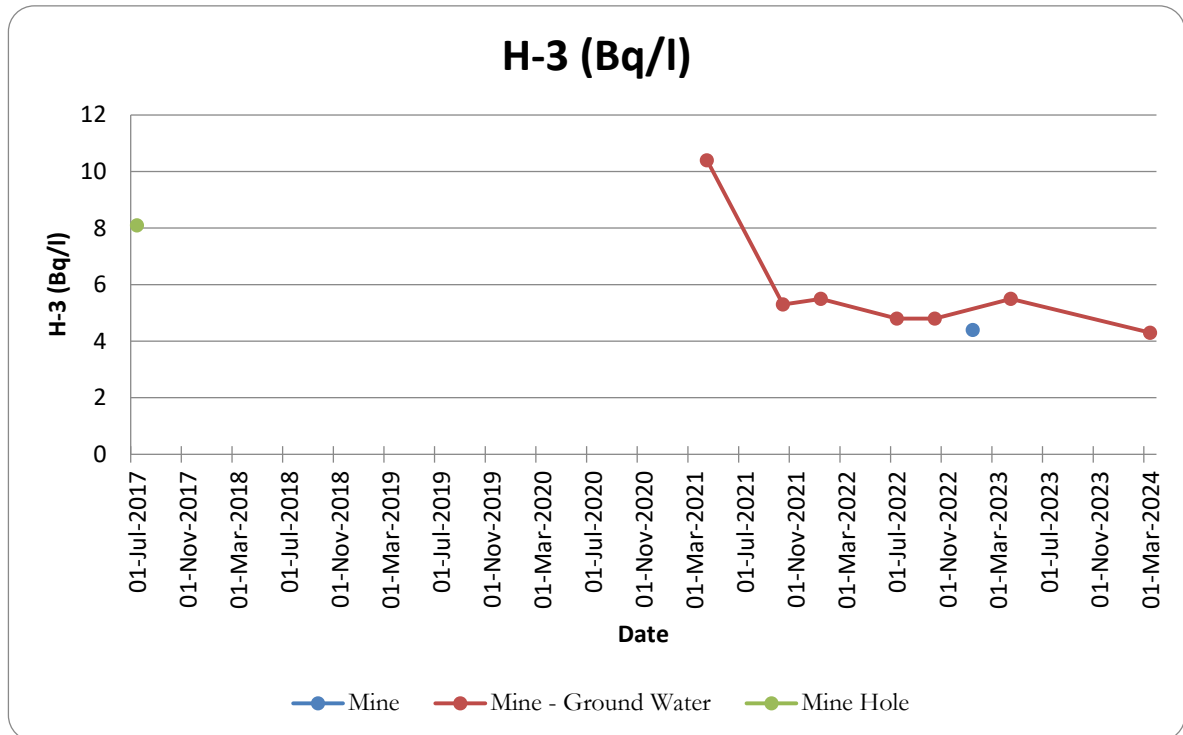


Figure 168: Tritium Concentration timeseries within the Mine Void

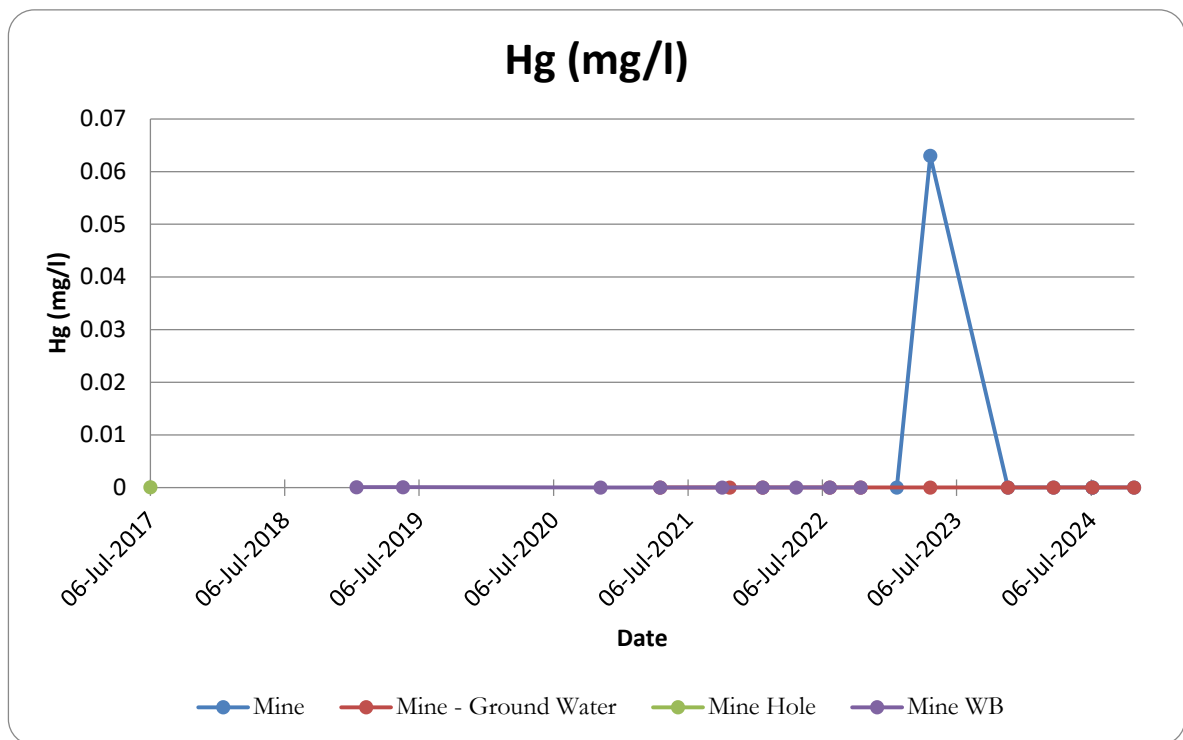


Figure 169: Hg Concentration timeseries within the Mine Void

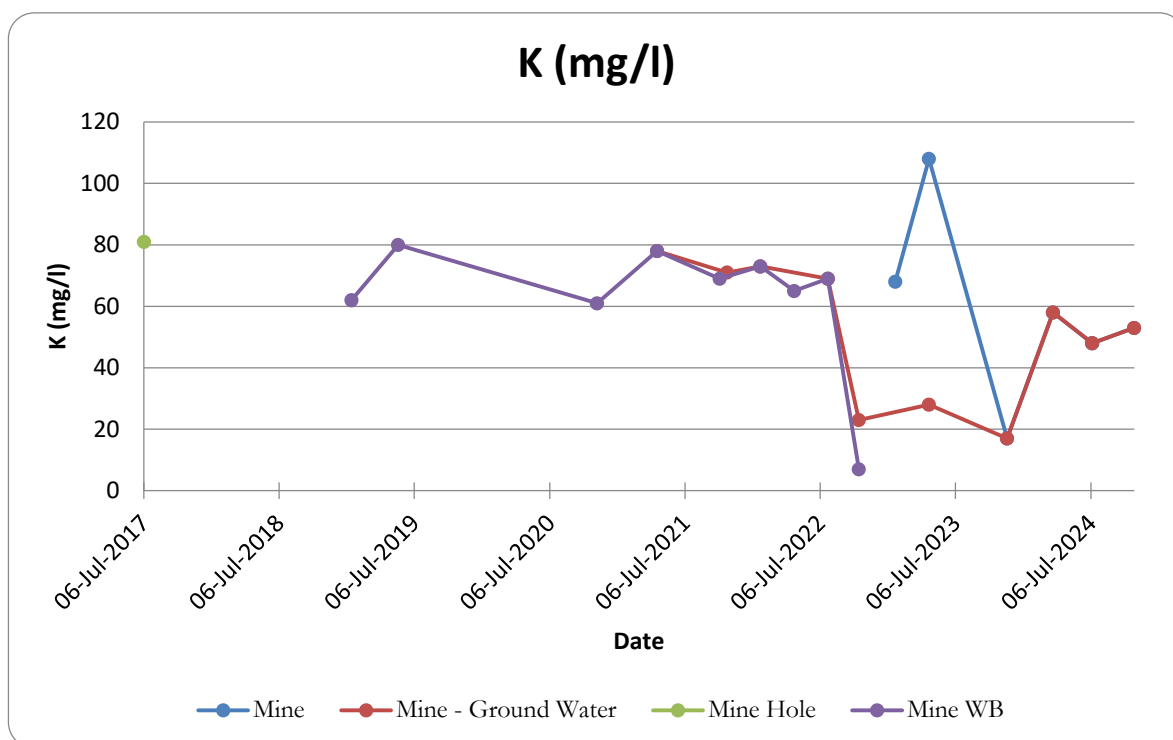


Figure 170: K Concentration timeseries within the Mine Void

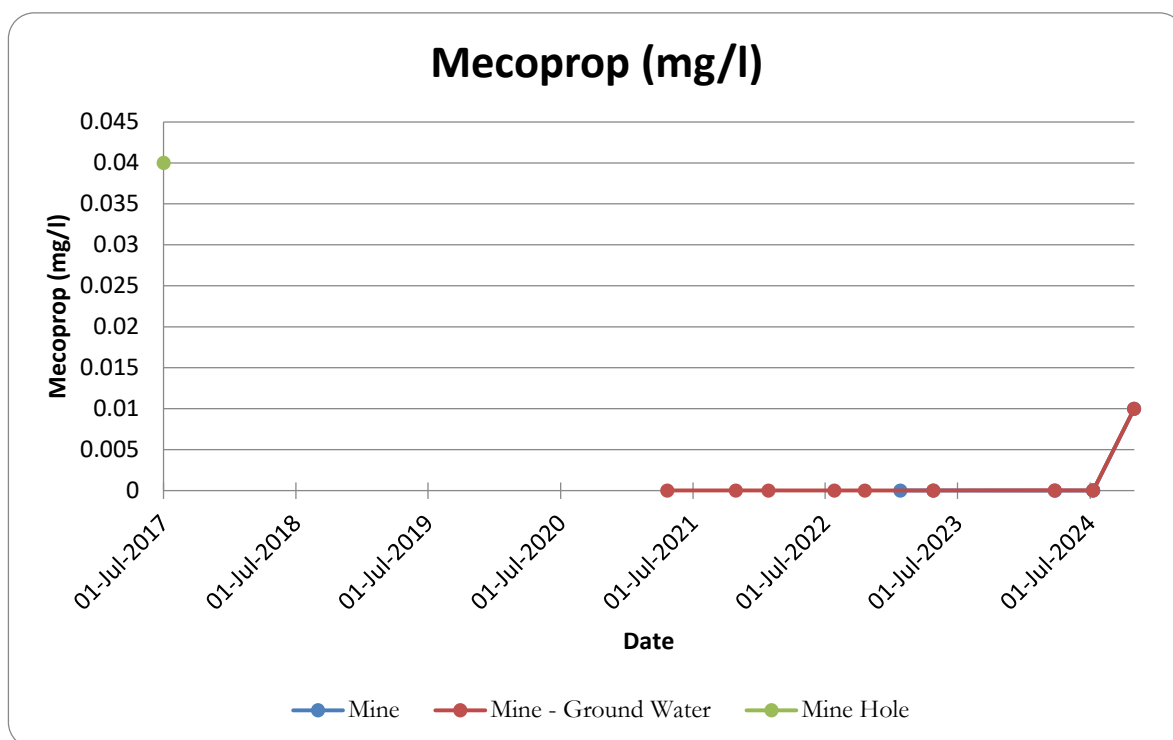


Figure 171: Mecoprop Concentration timeseries within the Mine Void

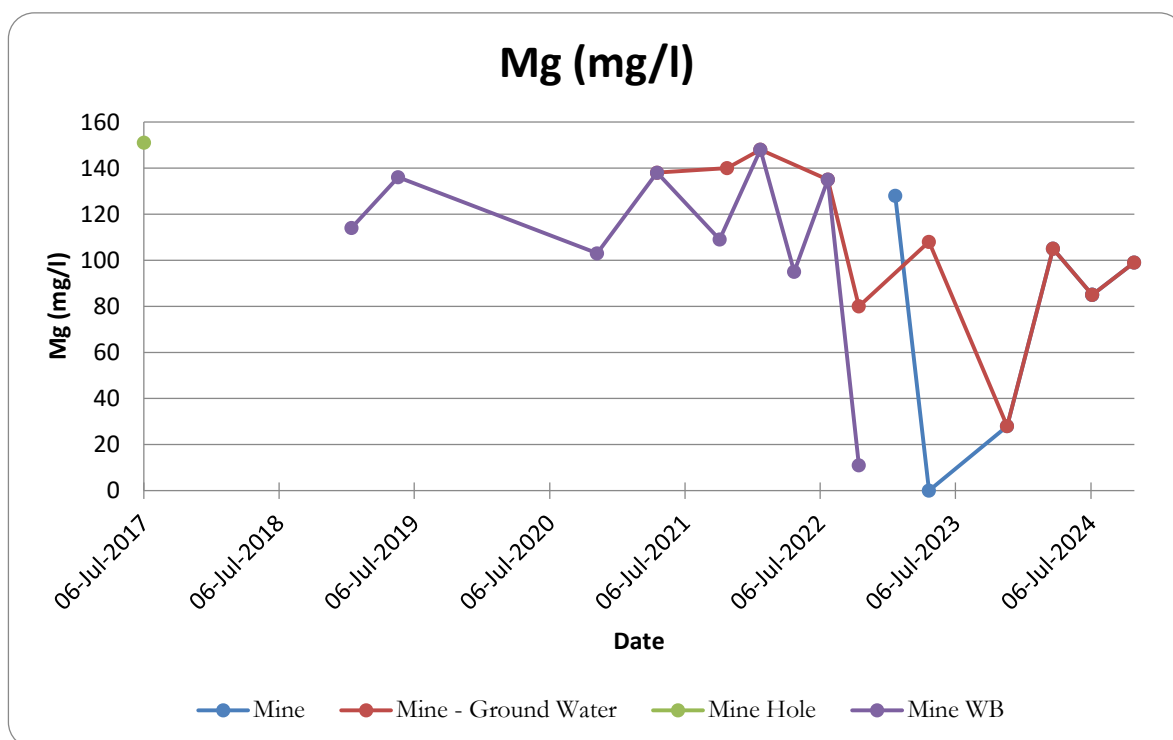


Figure 172: Mg Concentration timeseries within the Mine Void

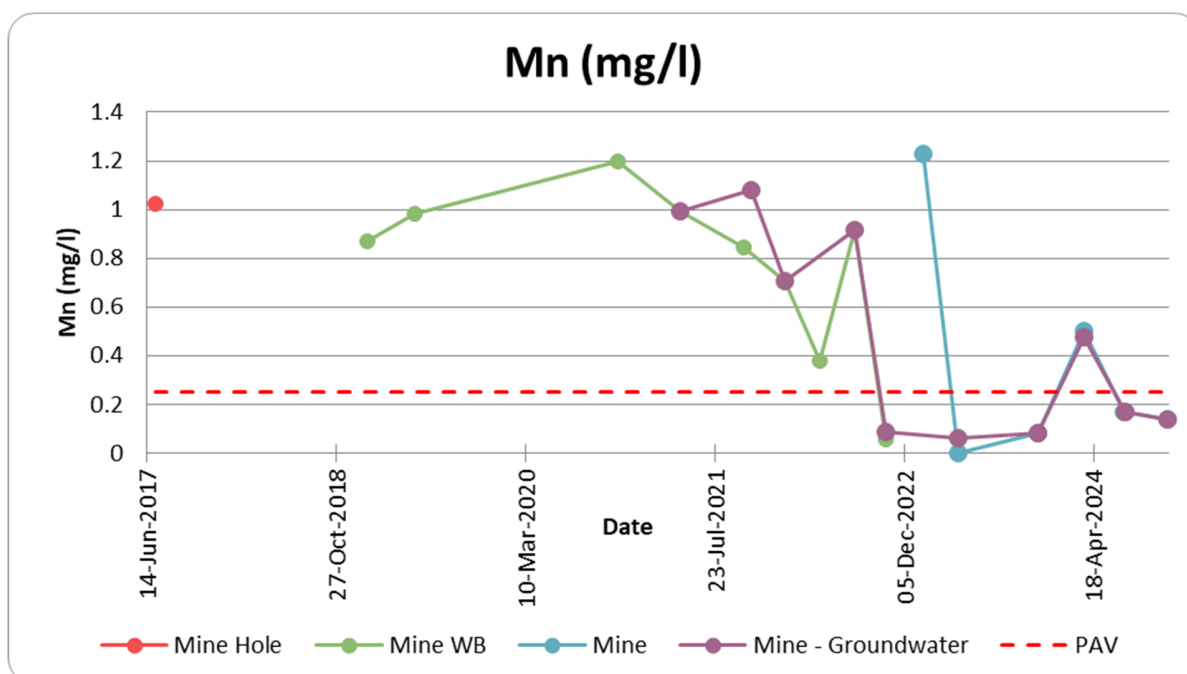


Figure 173: Mn Concentration timeseries within the Mine Void

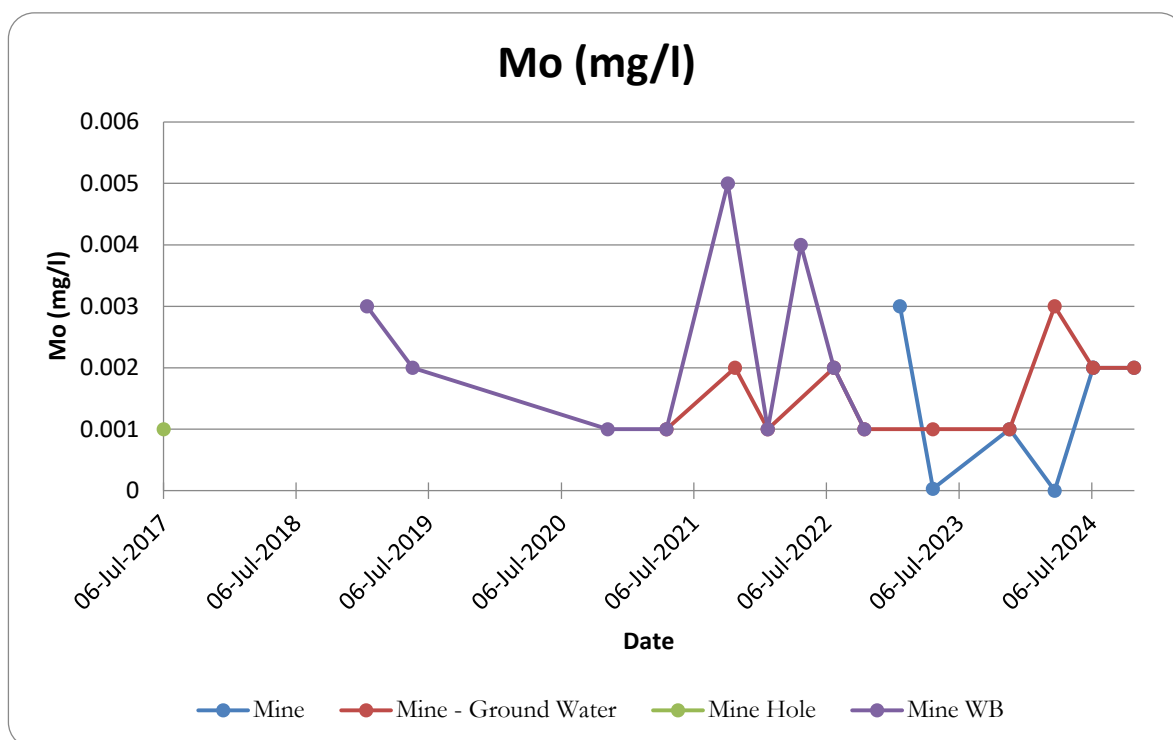


Figure 174: Mo Concentration timeseries within the Mine Void

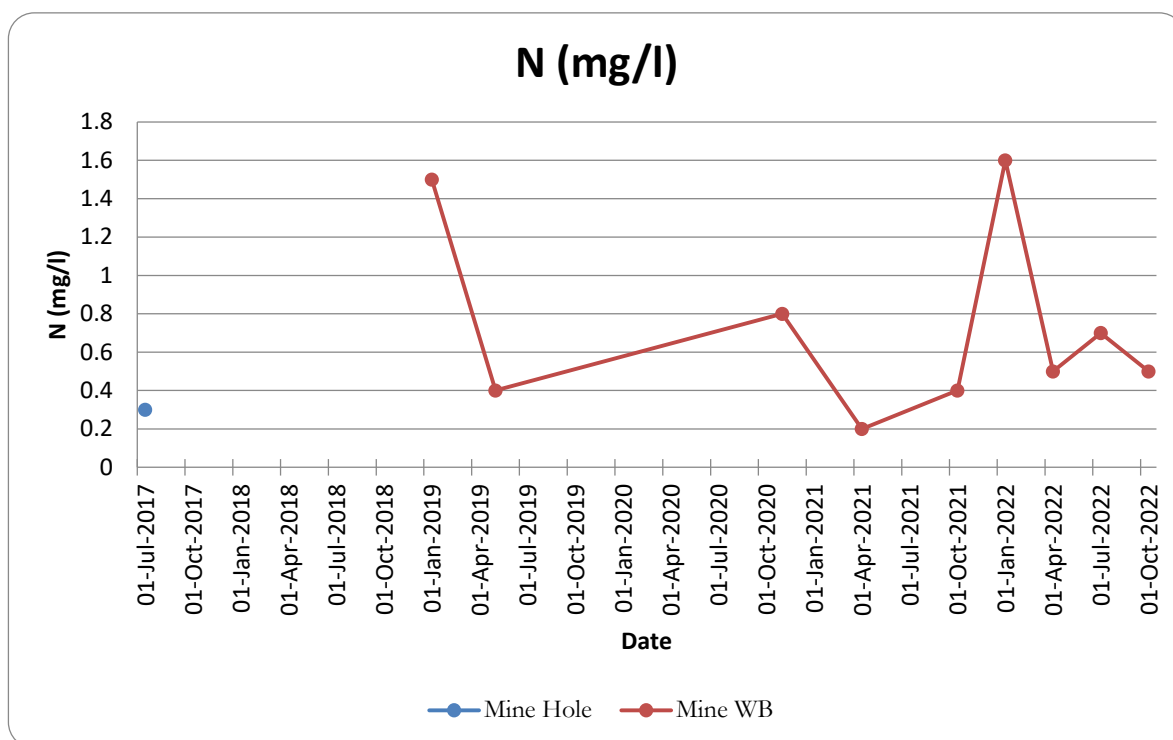


Figure 175: N Concentration timeseries within the Mine Void

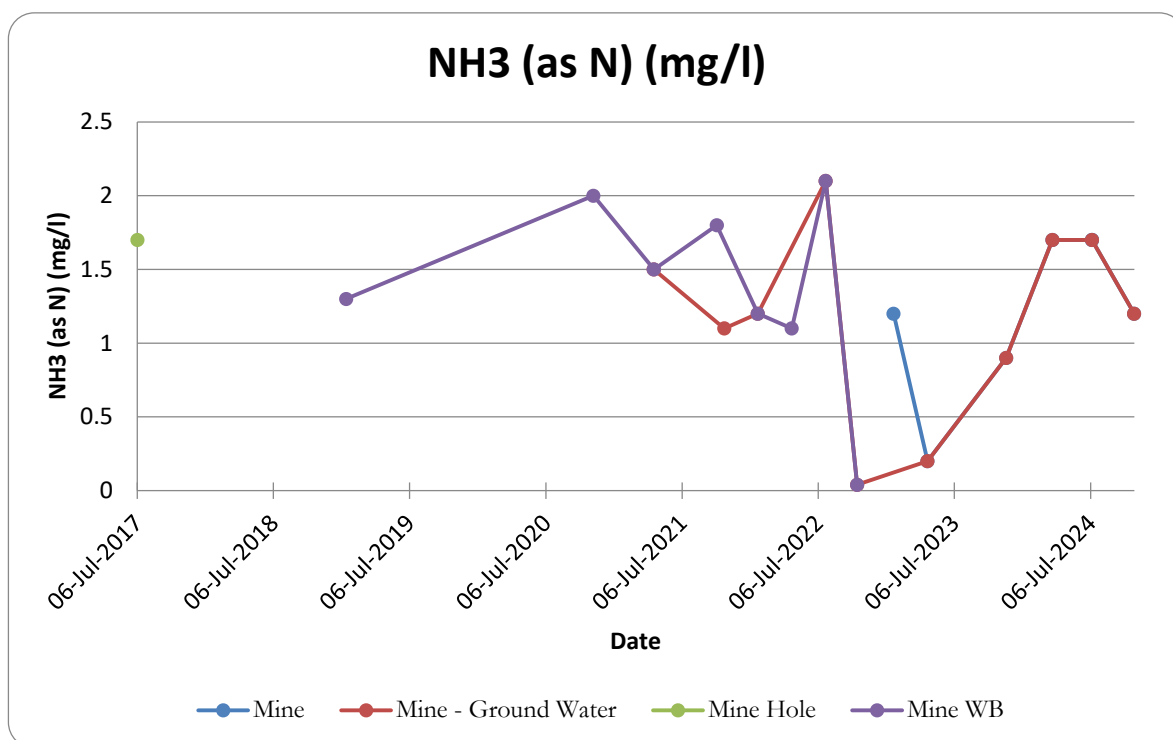


Figure 176: NH3 (as N) Concentration timeseries within the Mine Void

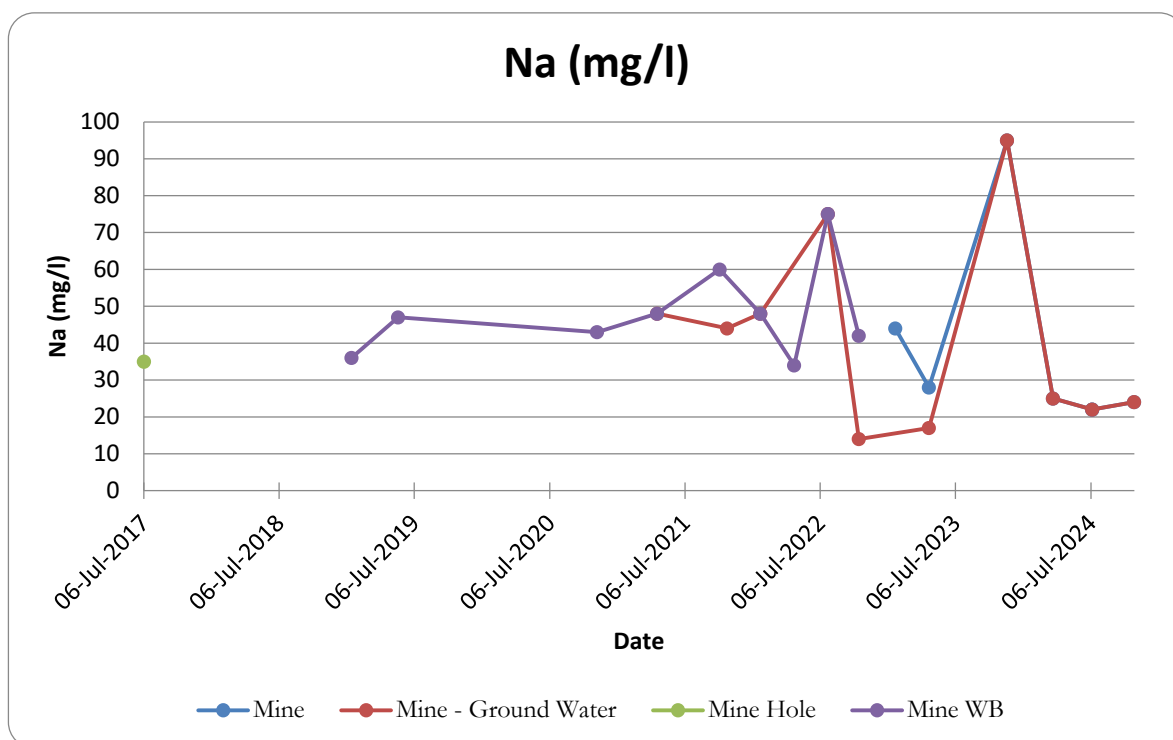


Figure 177: Na Concentration timeseries within the Mine Void

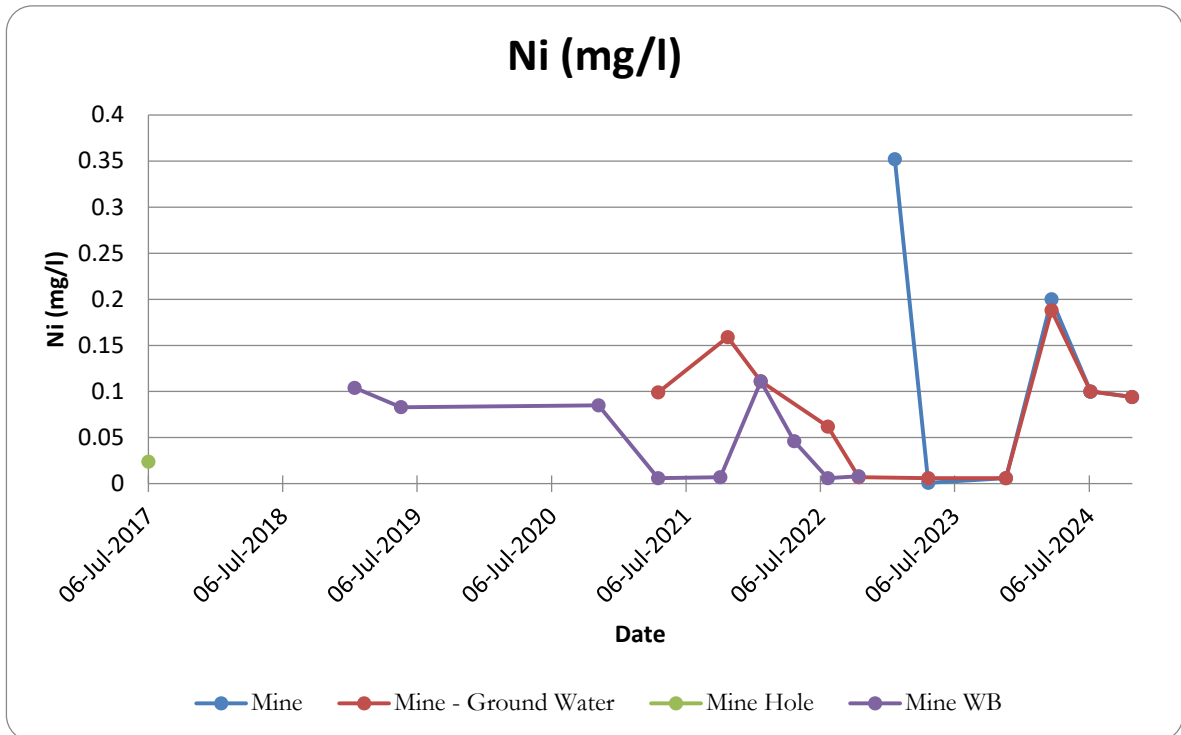


Figure 178: Ni Concentration timeseries within the Mine Void

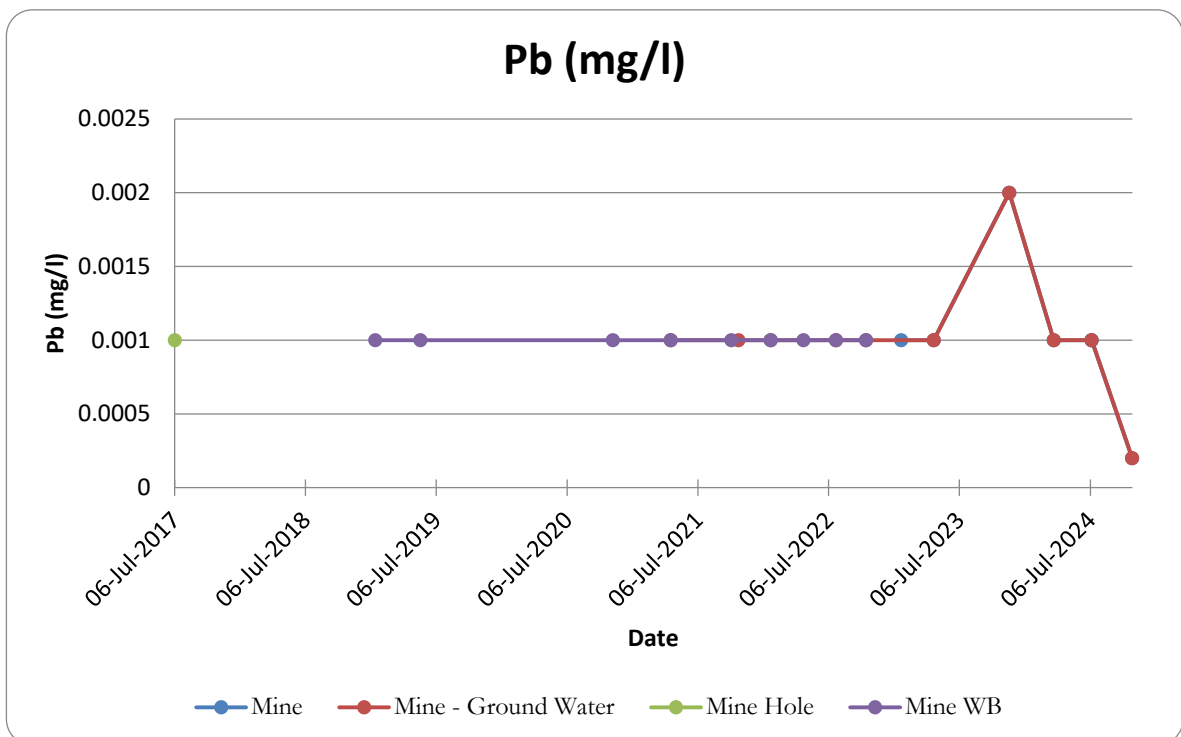


Figure 179: Pb Concentration timeseries within the Mine Void

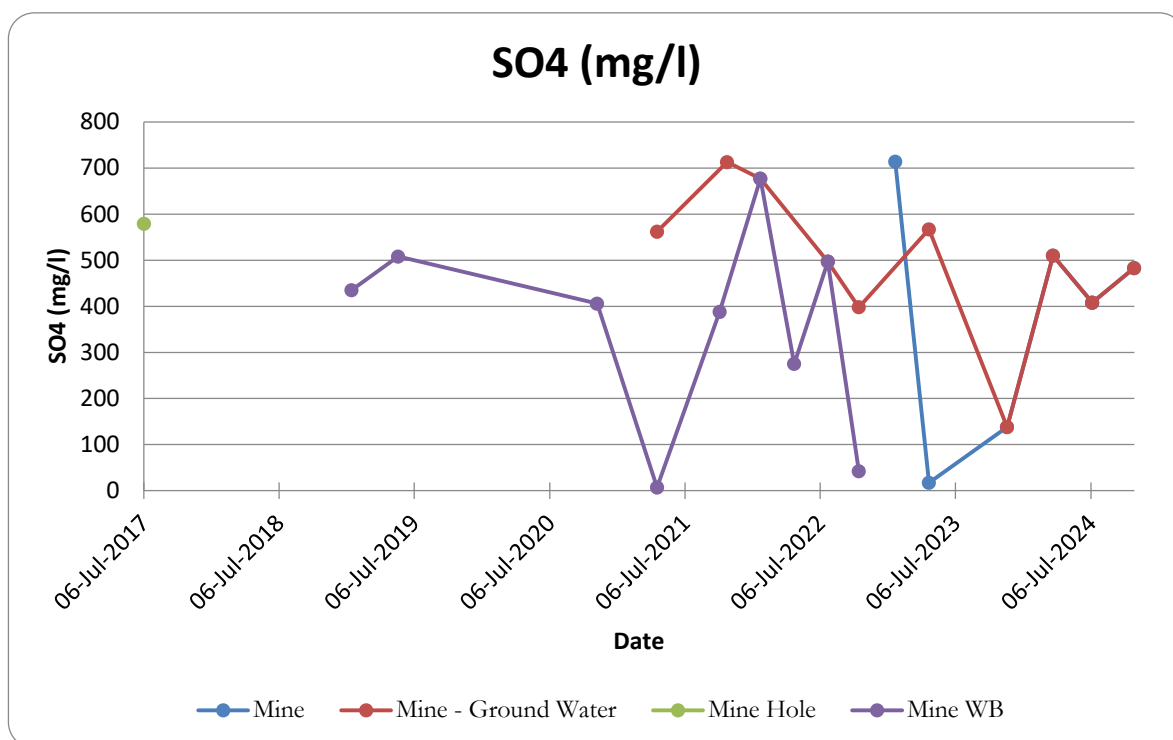


Figure 180: SO<sub>4</sub> Concentration timeseries within the Mine Void

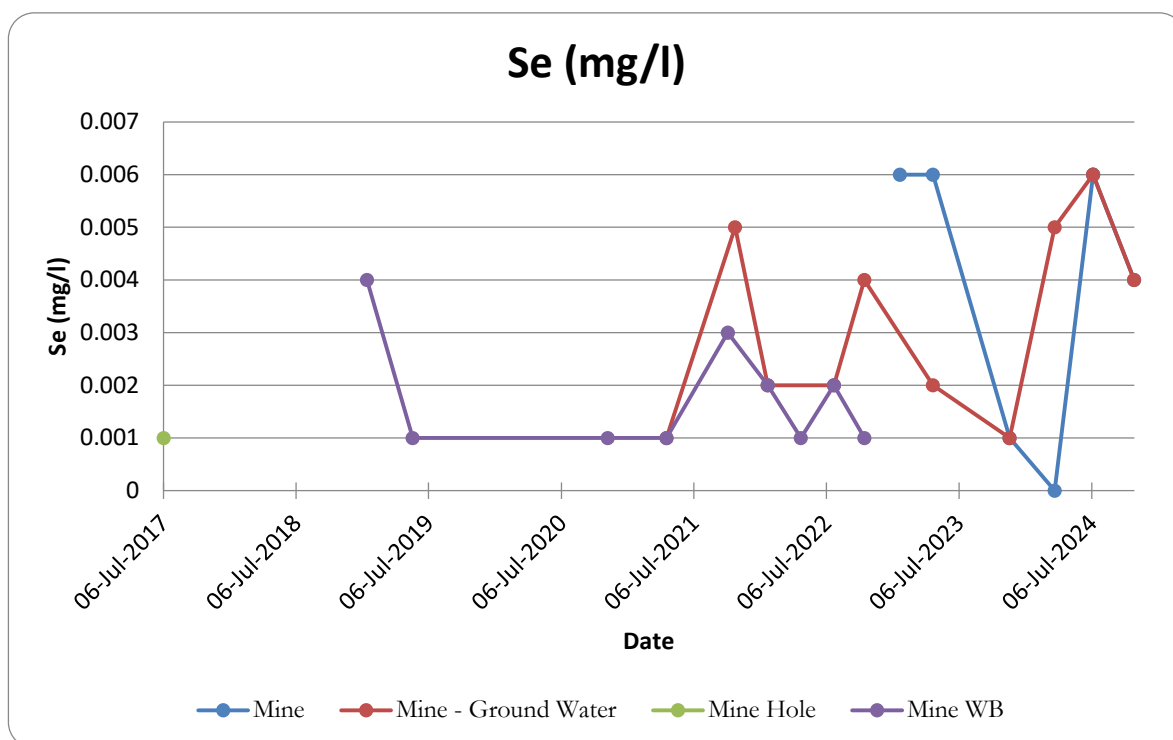


Figure 181: Se Concentration timeseries within the Mine Void

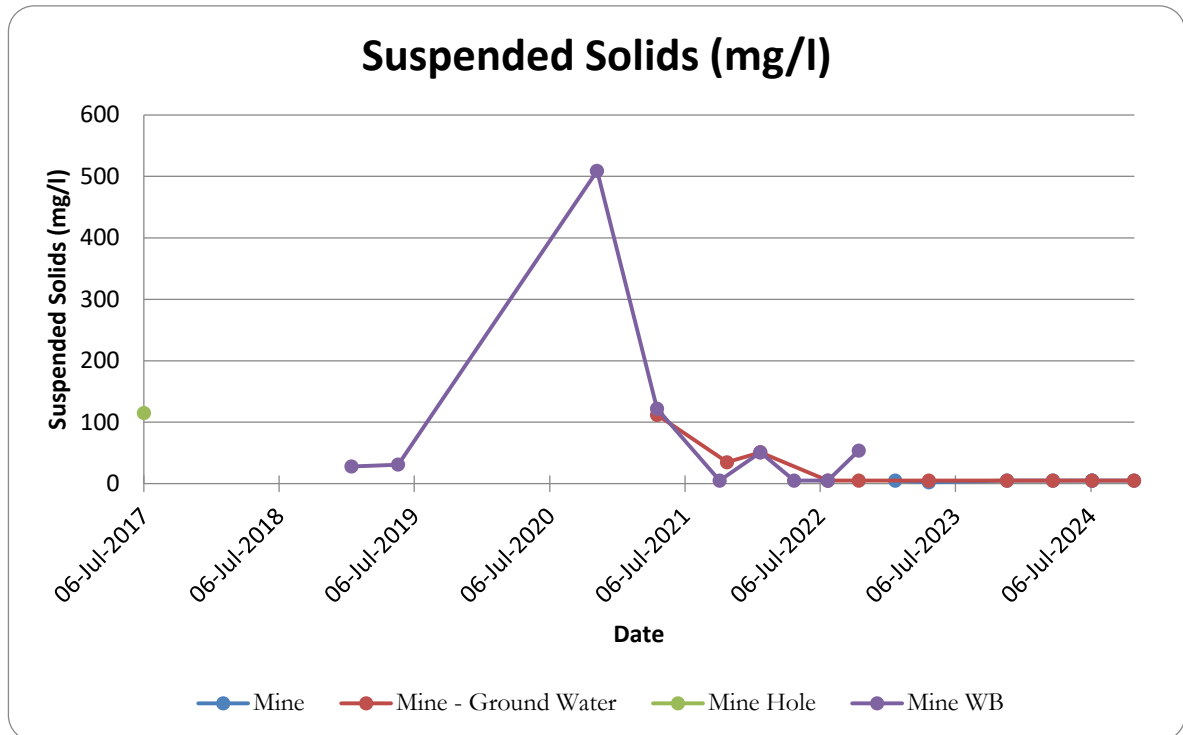


Figure 182: Suspended Solids Concentration timeseries within the Mine Void

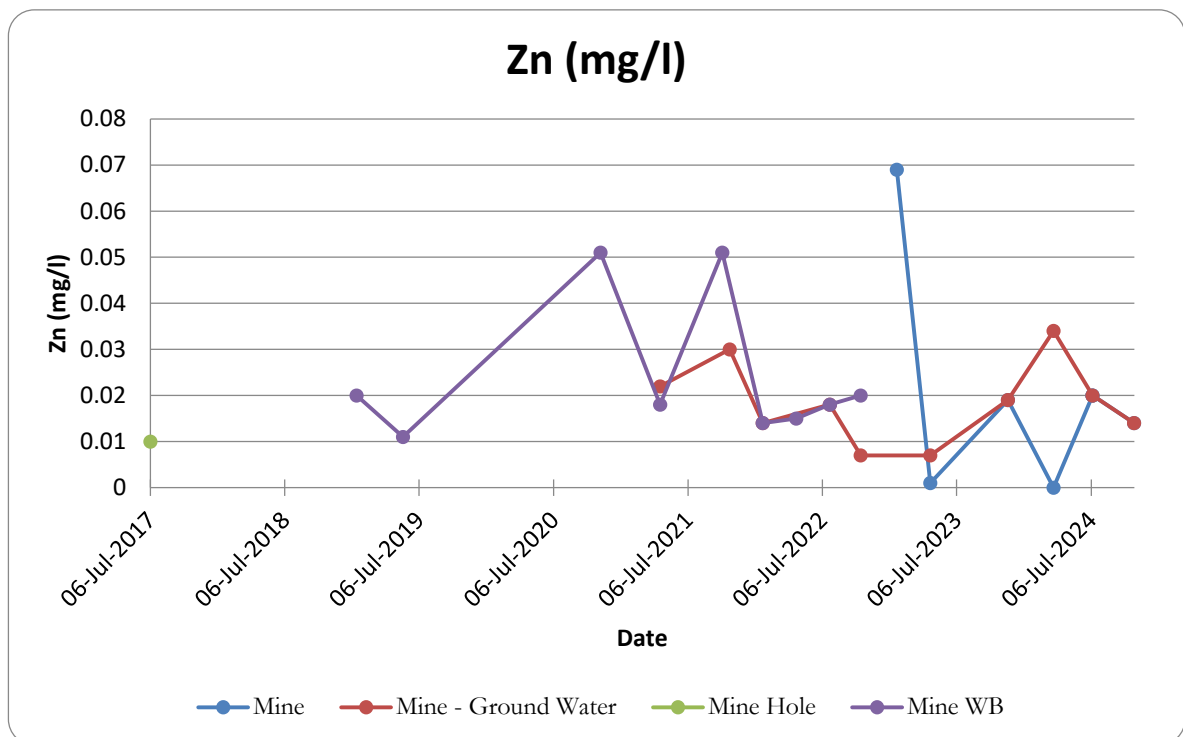


Figure 183: Zn Concentration timeseries within the Mine Void

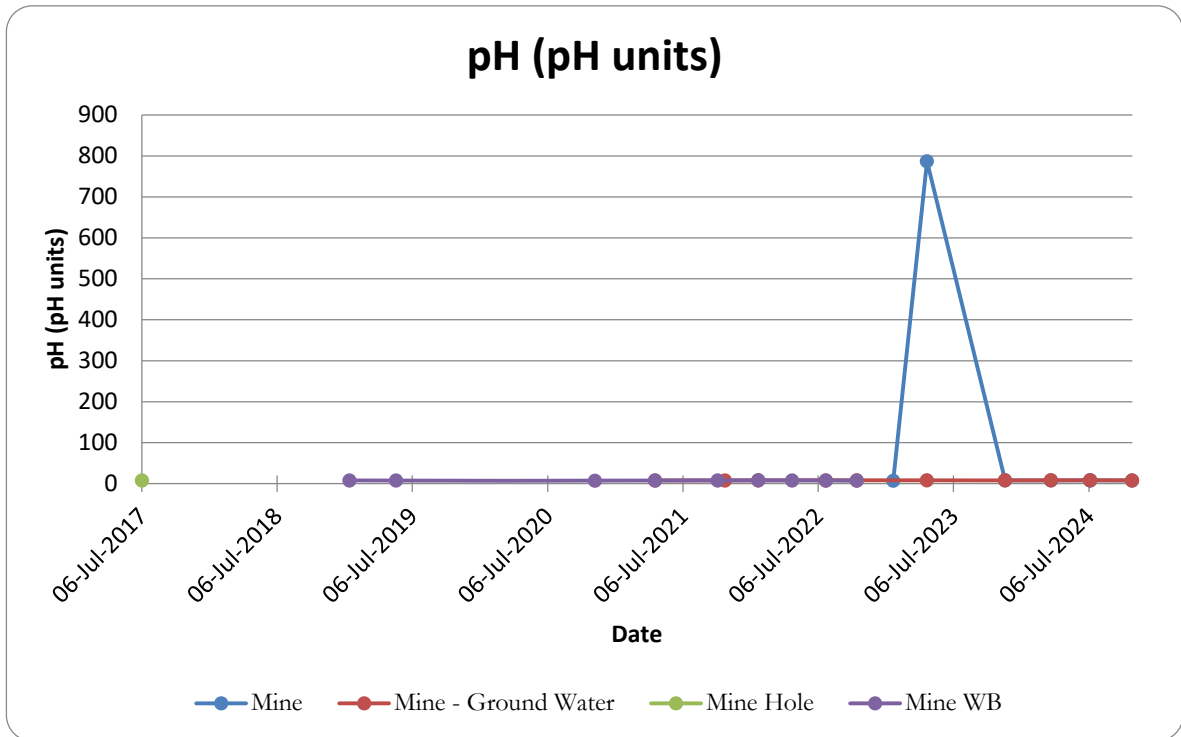


Figure 184: pH Concentration timeseries within the Mine Void

## 11 OB3 WATER TREATMENT STUDY

Table 13 OB3 Water Treatment Study Monitoring Point Statistics

| Parameter  | Units | Stat  | WF1     | WF2 | WF3 | WF4   |
|------------|-------|-------|---------|-----|-----|-------|
| Al         | mg/l  | min   | 0.01    |     | 0   | 0     |
|            |       | max   | 0.01    |     | 0   | 0     |
|            |       | mean  | 0.01    |     | 0   | 0     |
|            |       | count | 1       |     | 1   | 2     |
| Alkalinity | mg/l  | min   | 186     | 216 | 222 | 186   |
|            |       | max   | 186     | 216 | 222 | 198   |
|            |       | mean  | 186     | 216 | 222 | 192   |
|            |       | count | 1       | 1   | 1   | 2     |
| As         | mg/l  | min   | 0.001   |     | 0   | 0     |
|            |       | max   | 0.001   |     | 0   | 0     |
|            |       | mean  | 0.001   |     | 0   | 0     |
|            |       | count | 1       |     | 1   | 2     |
| Ca         | mg/l  | min   | 68      | 90  | 163 | 92    |
|            |       | max   | 68      | 90  | 163 | 93    |
|            |       | mean  | 68      | 90  | 163 | 92.5  |
|            |       | count | 1       | 1   | 1   | 2     |
| Cd         | mg/l  | min   | 0.00002 |     | 0   | 0     |
|            |       | max   | 0.00002 |     | 0   | 0     |
|            |       | mean  | 0.00002 |     | 0   | 0     |
|            |       | count | 1       |     | 1   | 2     |
| Cl         | mg/l  | min   | 2       | 2   | 3   | 3     |
|            |       | max   | 2       | 2   | 3   | 4     |
|            |       | mean  | 2       | 2   | 3   | 3.5   |
|            |       | count | 1       | 1   | 1   | 2     |
| Cr         | mg/l  | min   | 0.002   |     | 0   | 0     |
|            |       | max   | 0.002   |     | 0   | 0     |
|            |       | mean  | 0.002   |     | 0   | 0     |
|            |       | count | 1       |     | 1   | 2     |
| Cu         | mg/l  | min   | 0.001   |     | 0   | 0     |
|            |       | max   | 0.001   |     | 0   | 0     |
|            |       | mean  | 0.001   |     | 0   | 0     |
|            |       | count | 1       |     | 1   | 2     |
| Fe         | mg/l  | min   | 0.01    | 0   | 22  | 0     |
|            |       | max   | 0.01    | 0   | 22  | 0     |
|            |       | mean  | 0.01    | 0   | 22  | 0     |
|            |       | count | 1       | 1   | 1   | 2     |
| Hg         | mg/l  | min   | 0.00003 |     | 0   | 0     |
|            |       | max   | 0.00003 |     | 0   | 0     |
|            |       | mean  | 0.00003 |     | 0   | 0     |
|            |       | count | 1       |     | 1   | 2     |
| K          | mg/l  | min   | 35      | 43  | 48  | 38    |
|            |       | max   | 35      | 43  | 48  | 41    |
|            |       | mean  | 35      | 43  | 48  | 39.5  |
|            |       | count | 1       | 1   | 1   | 2     |
| Mg         | mg/l  | min   | 97      | 125 | 193 | 126   |
|            |       | max   | 97      | 125 | 193 | 127   |
|            |       | mean  | 97      | 125 | 193 | 126.5 |



| Parameter        | Units    | Stat  | WF1    | WF2 | WF3  | WF4   |
|------------------|----------|-------|--------|-----|------|-------|
| Na               | mg/l     | count | 1      | 1   | 1    | 2     |
|                  |          | min   | 9      | 13  | 23   | 12    |
|                  |          | max   | 9      | 13  | 23   | 14    |
|                  |          | mean  | 9      | 13  | 23   | 13    |
| Ni               | mg/l     | count | 1      | 1   | 1    | 2     |
|                  |          | min   | 0.007  |     | 0    | 0     |
|                  |          | max   | 0.007  |     | 0    | 0     |
|                  |          | mean  | 0.007  |     | 0    | 0     |
| Pb               | mg/l     | count | 1      |     | 1    | 2     |
|                  |          | min   | 0.0002 |     | 0    | 0     |
|                  |          | max   | 0.0002 |     | 0    | 0     |
|                  |          | mean  | 0.0002 |     | 0    | 0     |
| SO4              | mg/l     | count | 1      |     | 1    | 2     |
|                  |          | min   | 423    | 585 | 1090 | 610   |
|                  |          | max   | 423    | 585 | 1090 | 615   |
|                  |          | mean  | 423    | 585 | 1090 | 612.5 |
| Suspended Solids | mg/l     | count | 1      | 1   | 1    | 2     |
|                  |          | min   | 23     | 13  | 44   | 5     |
|                  |          | max   | 23     | 13  | 44   | 11    |
|                  |          | mean  | 23     | 13  | 44   | 8     |
| Zn               | mg/l     | count | 1      | 1   | 1    | 2     |
|                  |          | min   | 0.027  |     | 0    | 0     |
|                  |          | max   | 0.027  |     | 0    | 0     |
|                  |          | mean  | 0.027  |     | 0    | 0     |
| pH               | pH units | count | 1      |     | 1    | 2     |
|                  |          | min   | 8      | 8.1 | 6.8  | 8.2   |
|                  |          | max   | 8      | 8.1 | 6.8  | 8.3   |
|                  |          | mean  | 8      | 8.1 | 6.8  | 8.25  |
|                  |          | count | 1      | 1   | 1    | 2     |

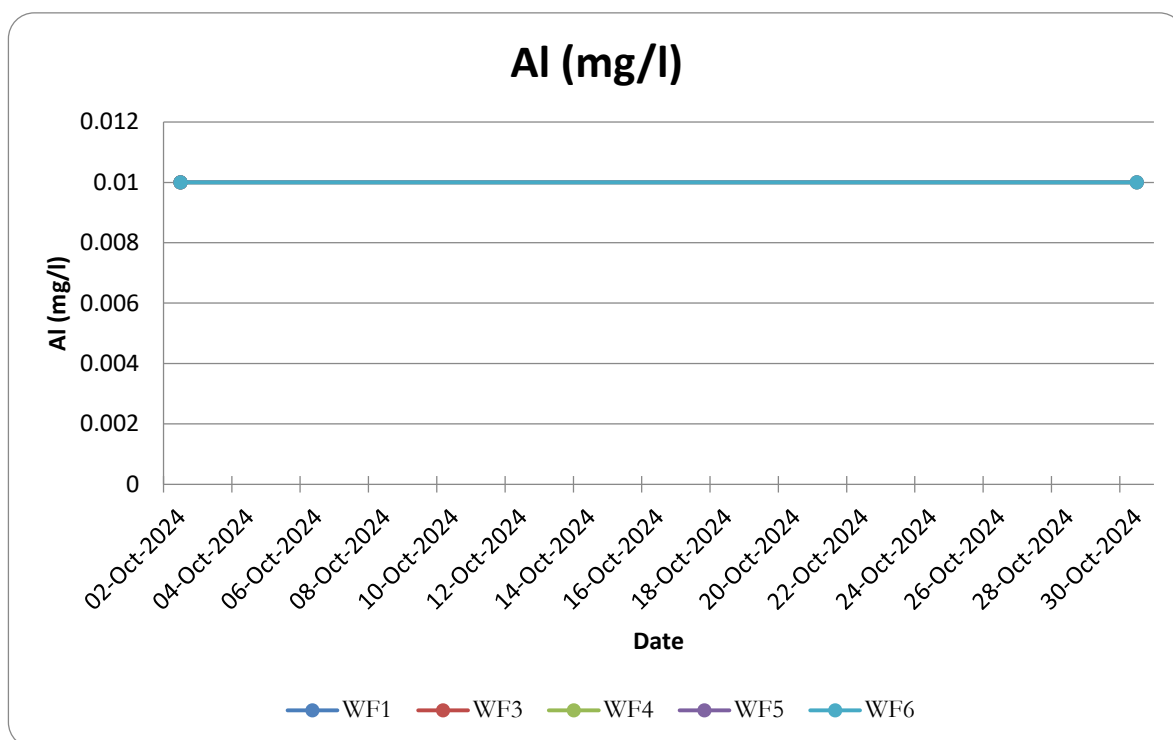


Figure 185: Al Concentration timeseries within the OB3 Water Treatment Study

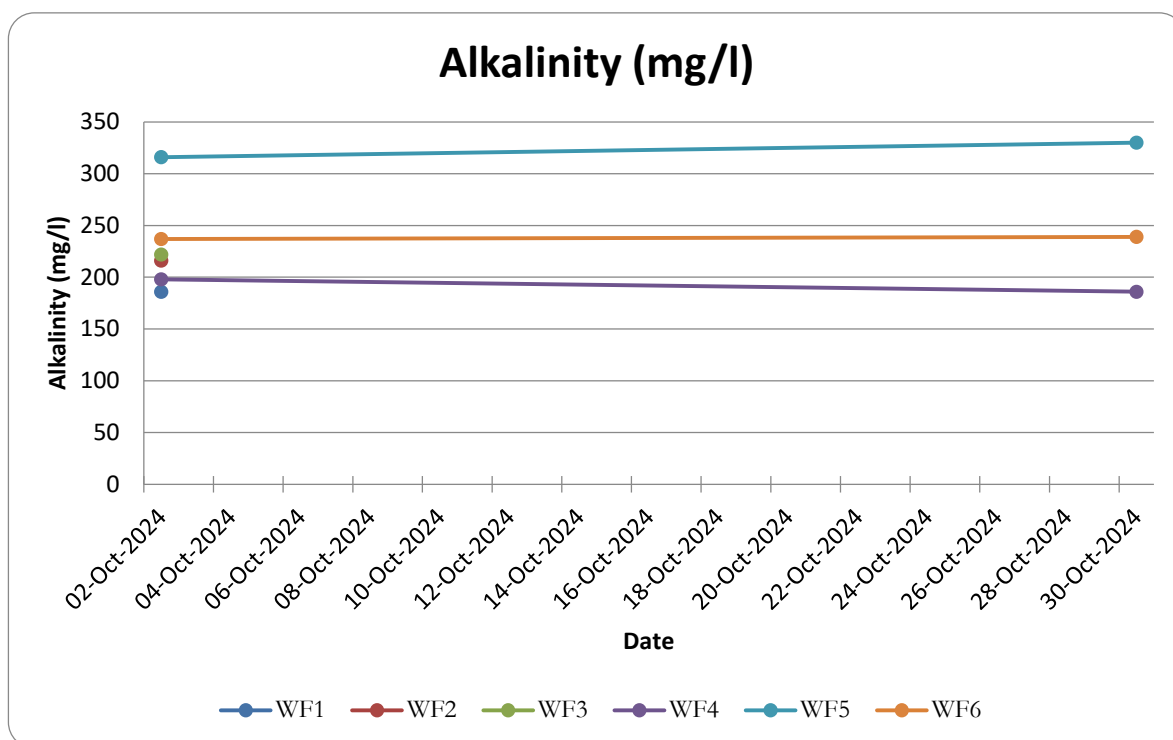


Figure 186: Alkalinity Concentration timeseries within the OB3 Water Treatment Study

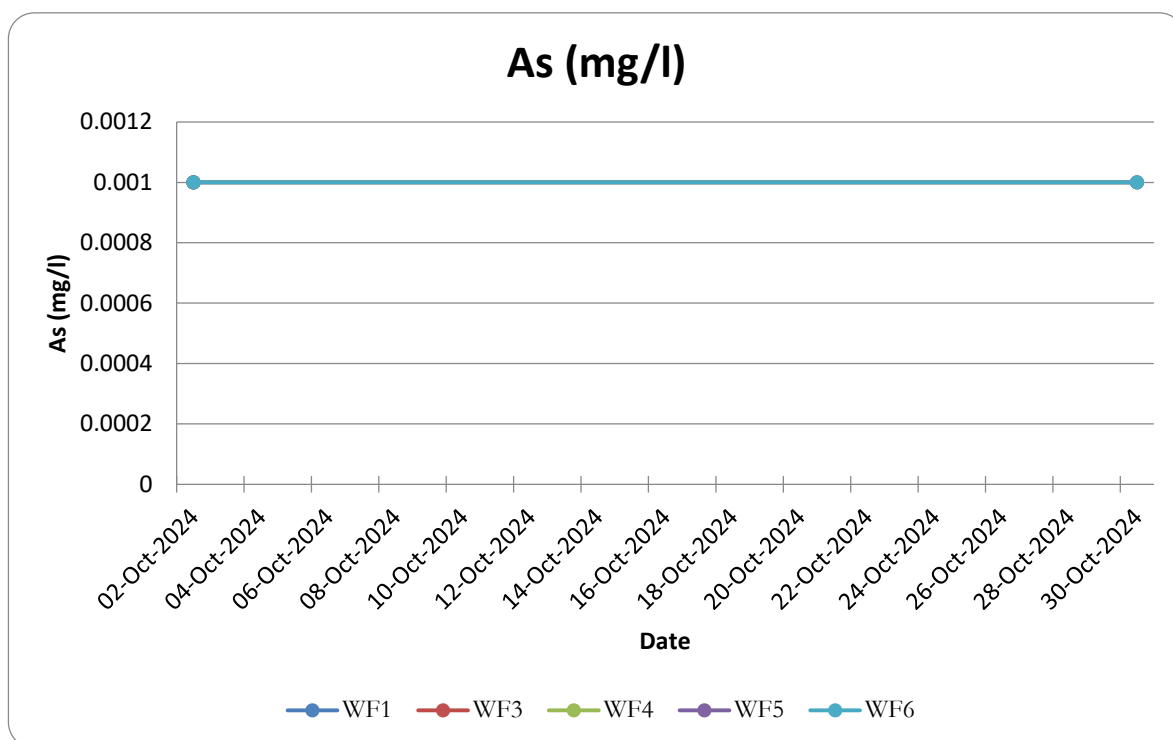


Figure 187: As Concentration timeseries within the OB3 Water Treatment Study

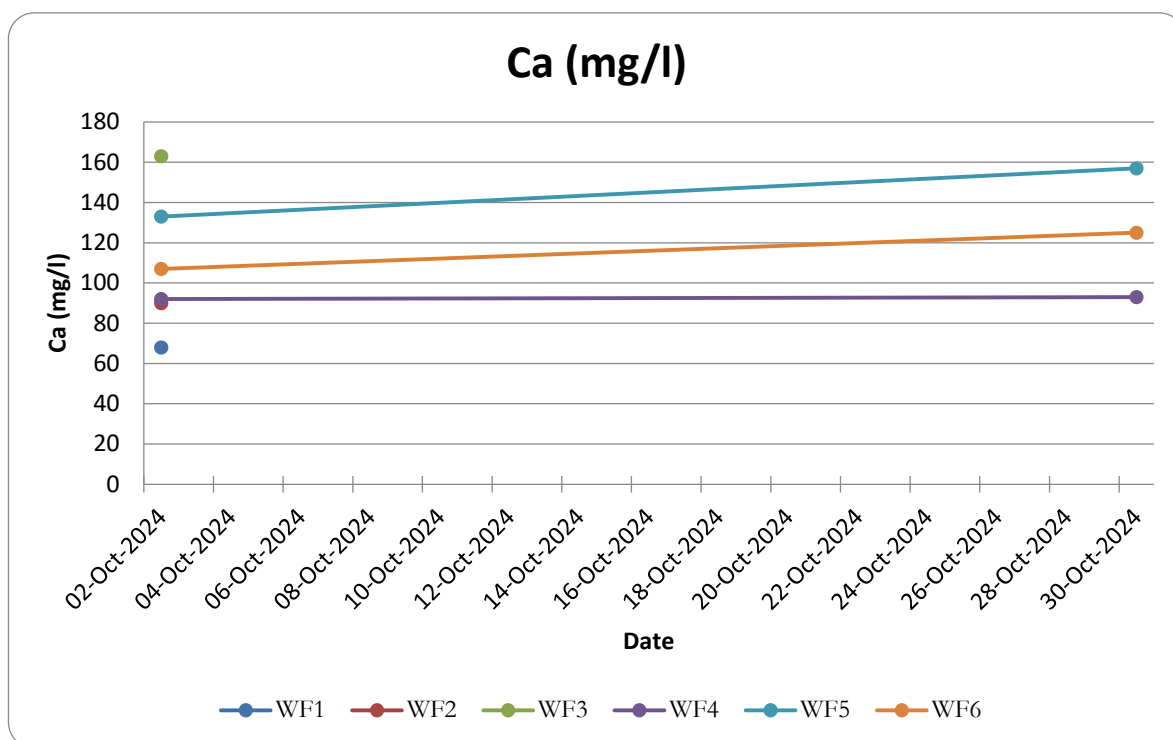


Figure 188: Ca Concentration timeseries within the OB3 Water Treatment Study

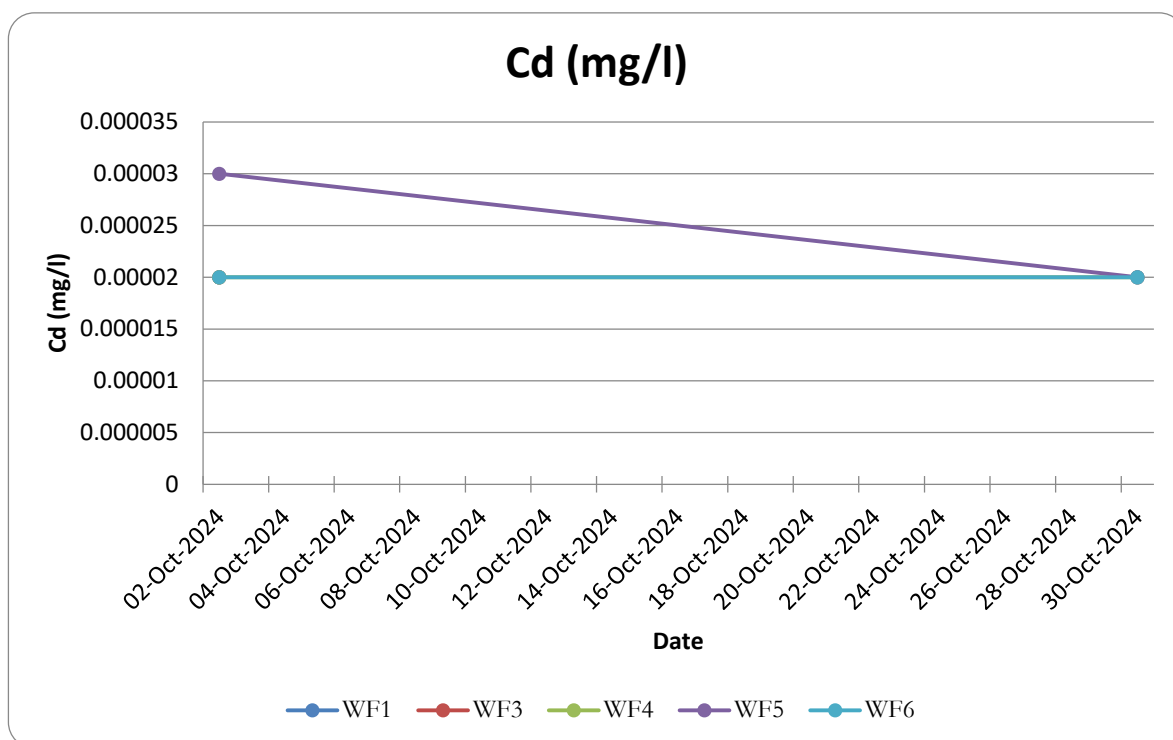


Figure 189: Cd Concentration timeseries within the OB3 Water Treatment Study

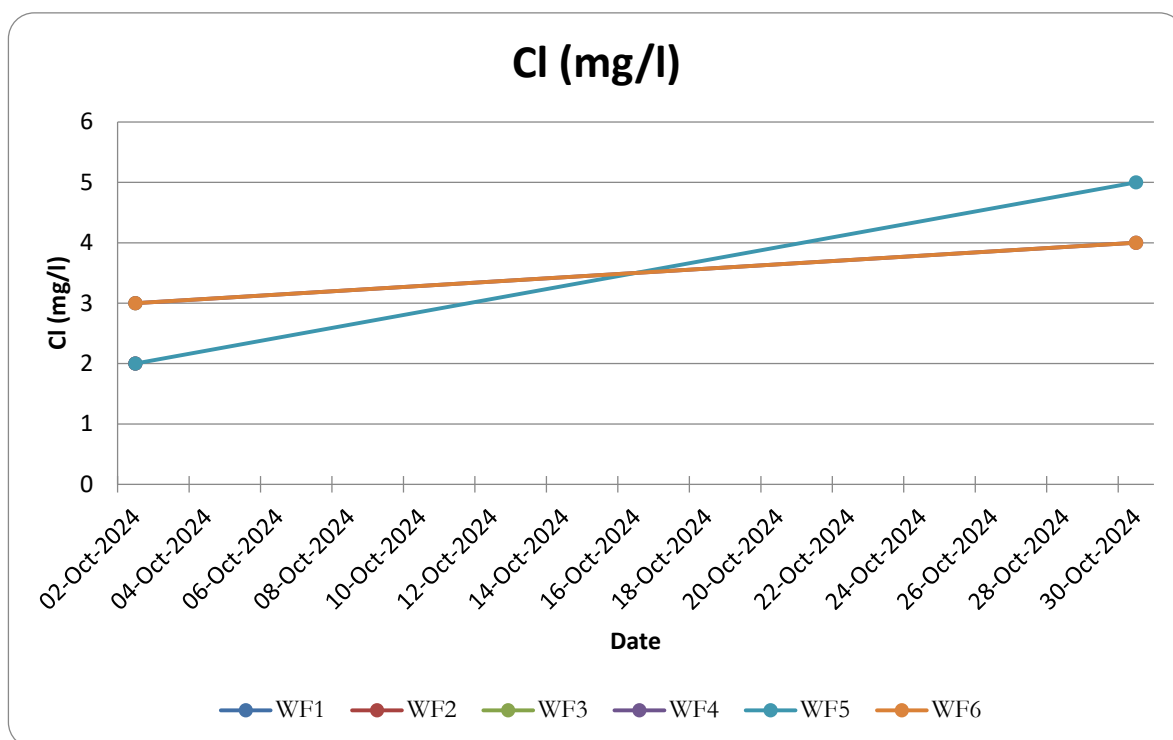


Figure 190: Cl Concentration timeseries within the OB3 Water Treatment Study

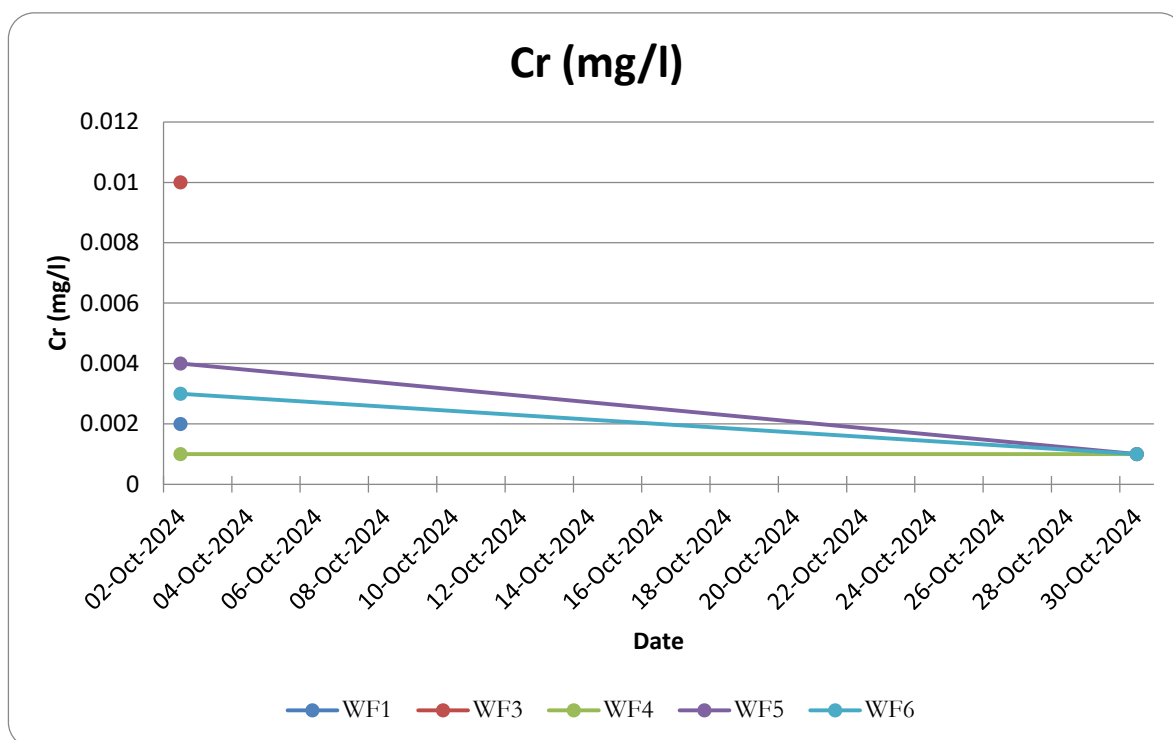


Figure 191:Cr Concentration timeseries within the OB3 Water Treatment Study

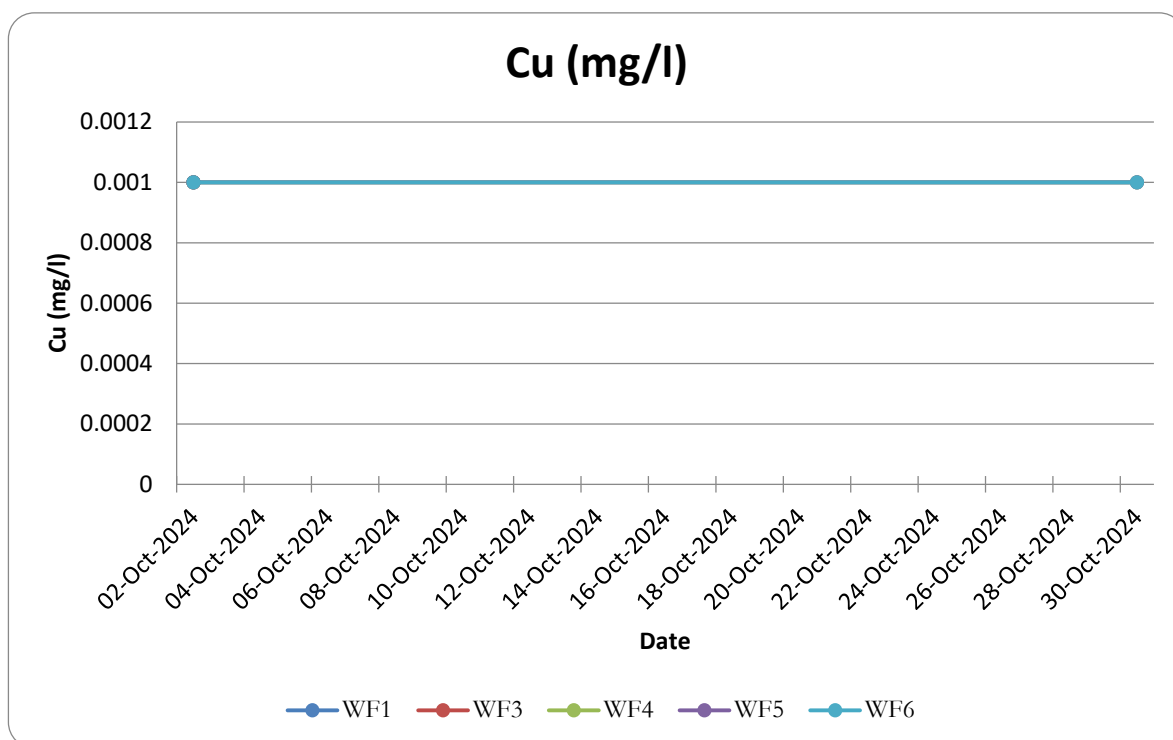


Figure 192:Cu Concentration timeseries within the OB3 Water Treatment Study

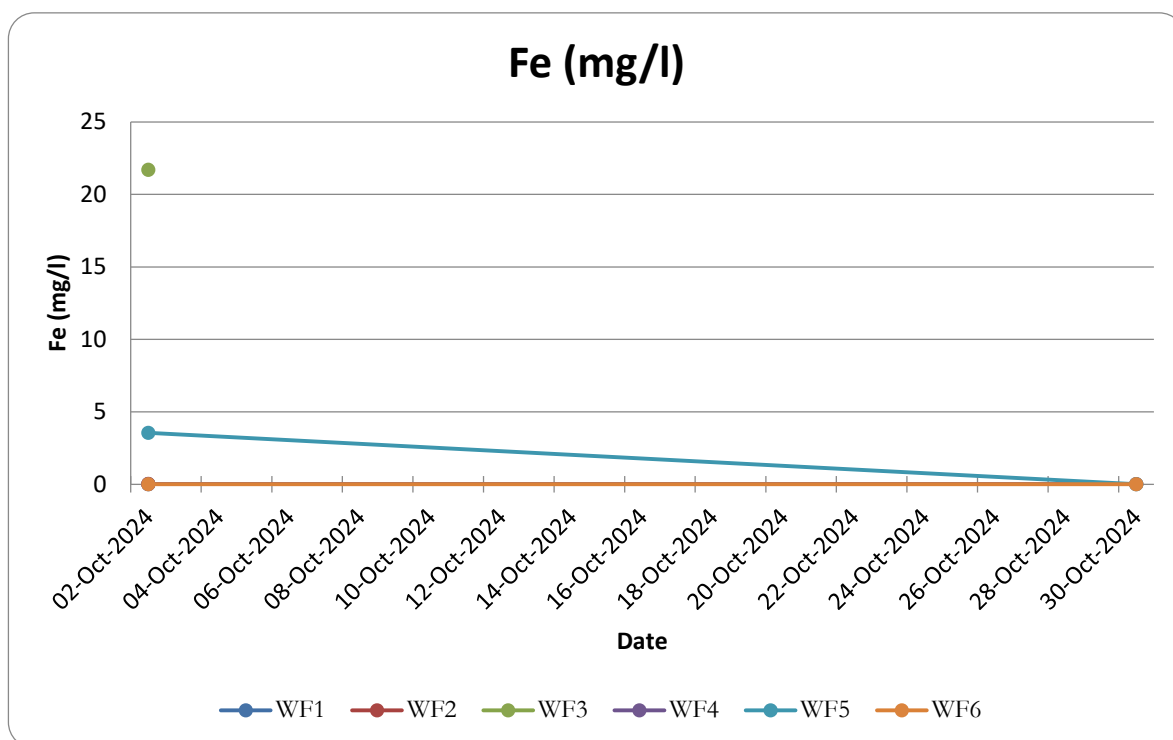


Figure 193: Fe Concentration timeseries within the OB3 Water Treatment Study

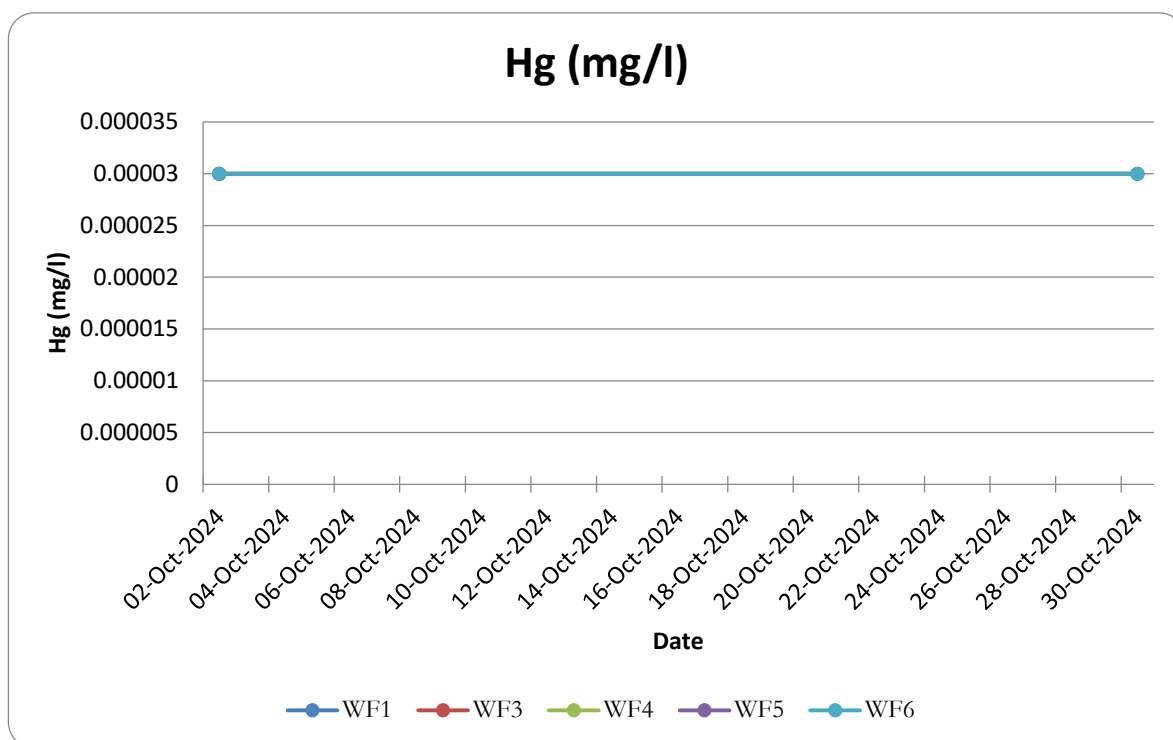


Figure 194: Hg Concentration timeseries within the OB3 Water Treatment Study

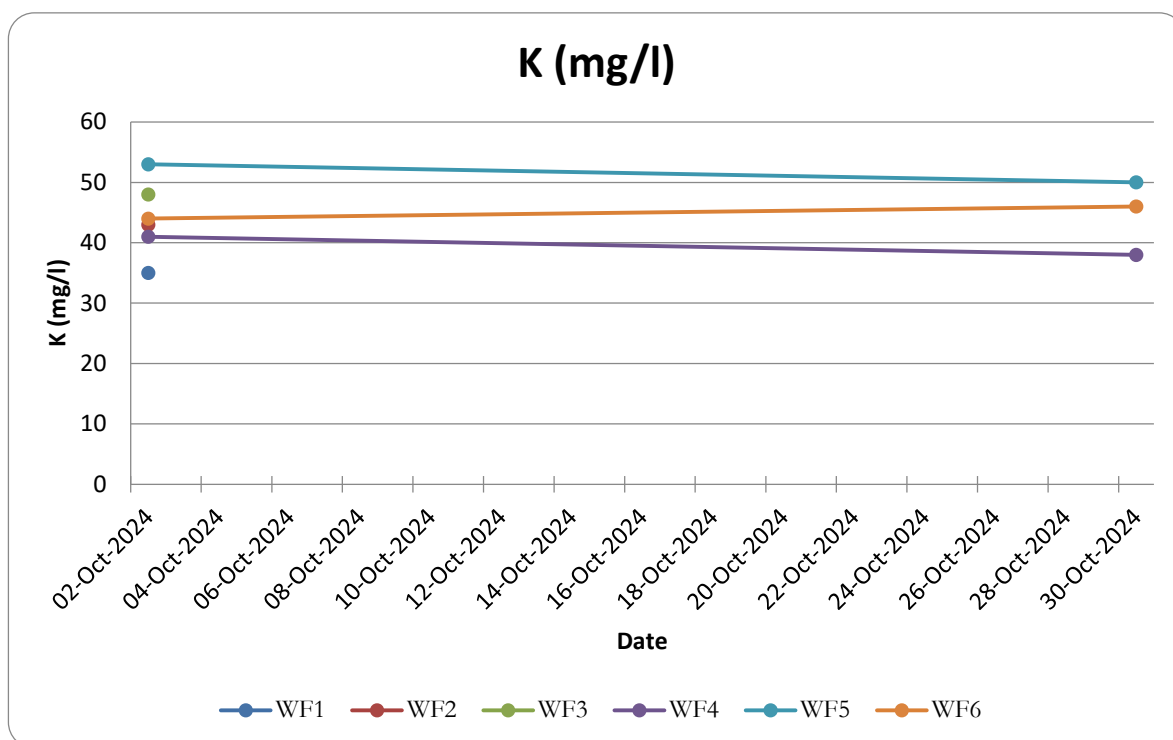


Figure 195: K Concentration timeseries within the OB3 Water Treatment Study

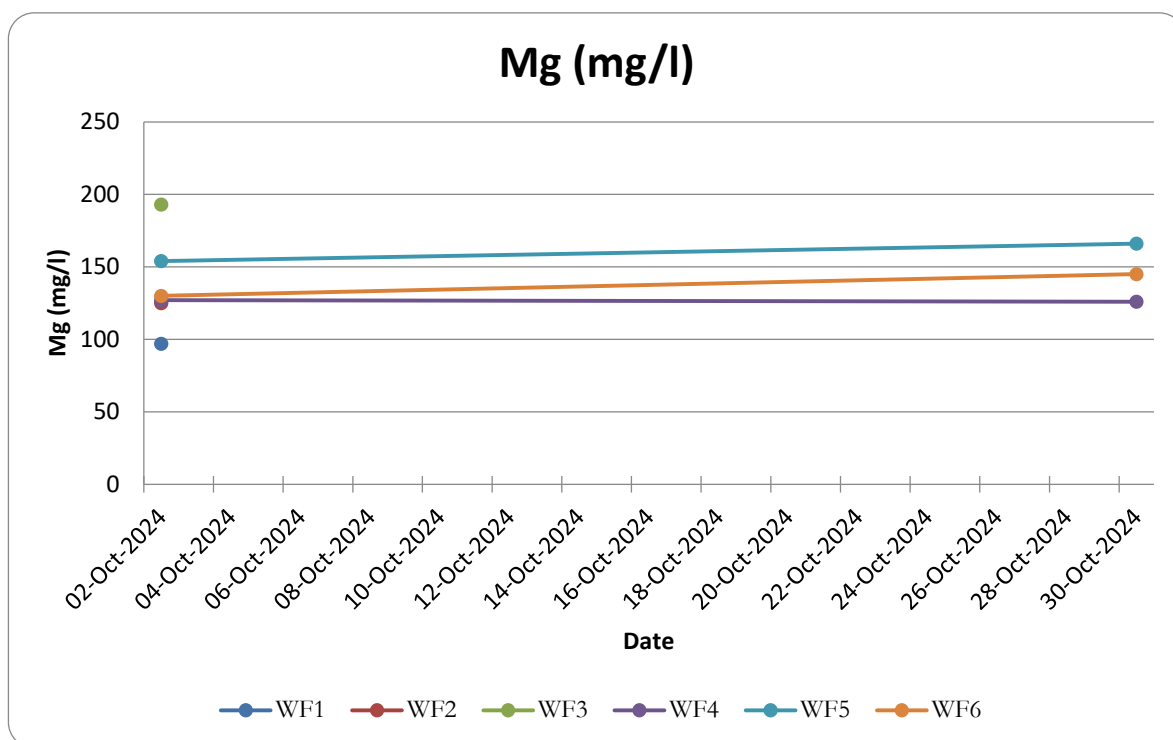


Figure 196: Mg Concentration timeseries within the OB3 Water Treatment Study

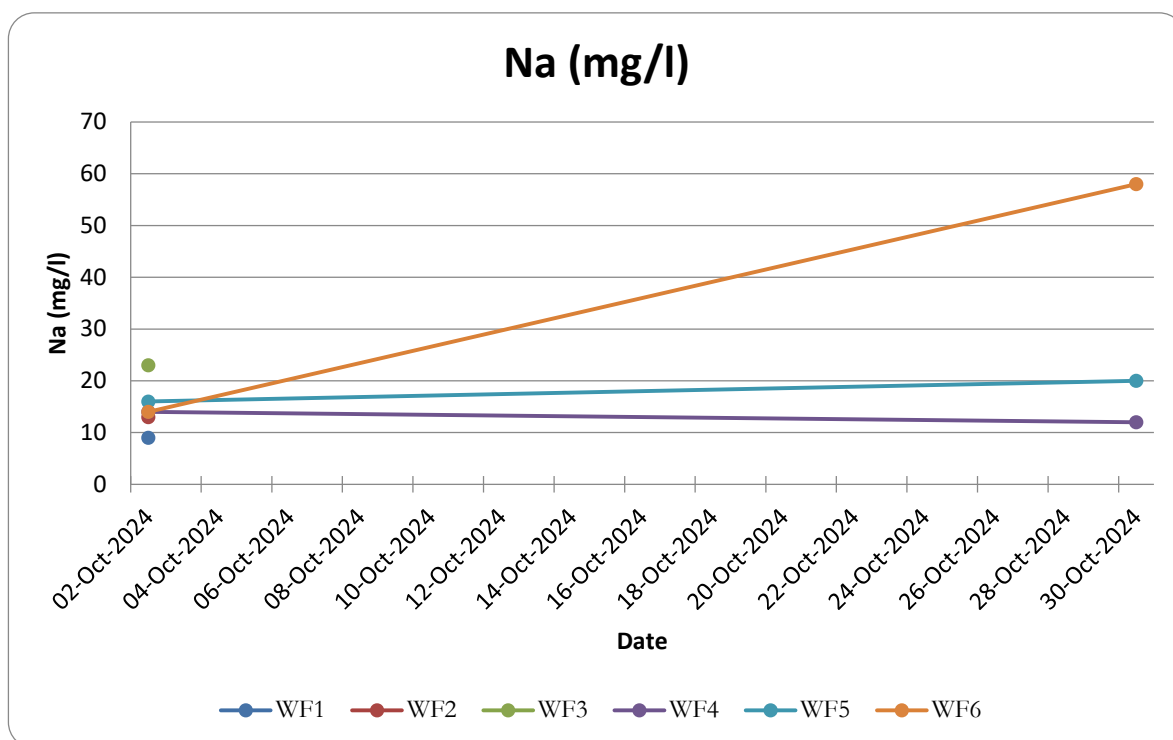


Figure 197: Na Concentration timeseries within the OB3 Water Treatment Study

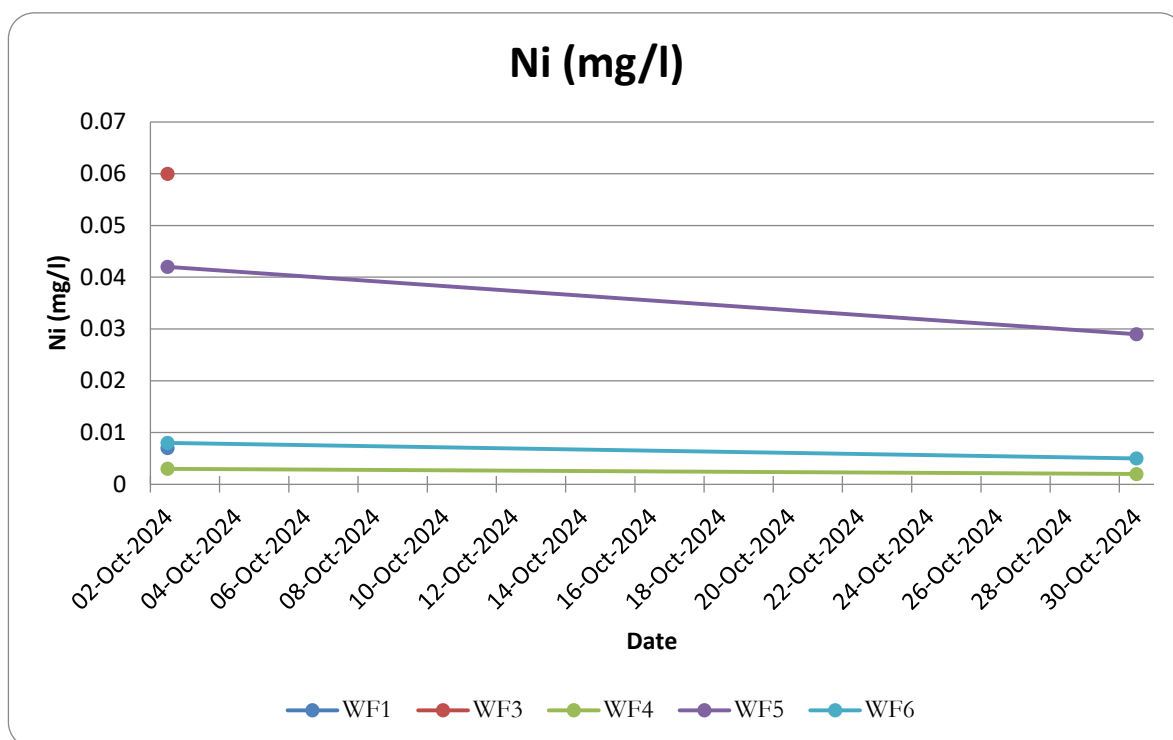


Figure 198: Ni Concentration timeseries within the OB3 Water Treatment Study

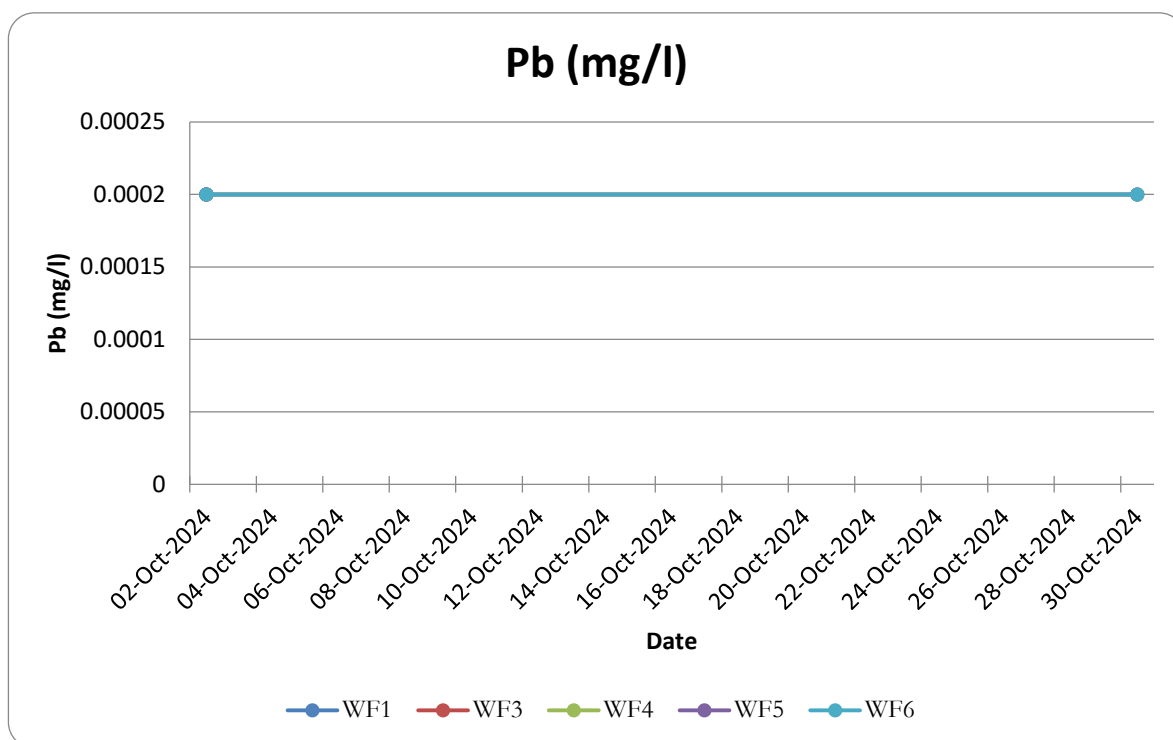


Figure 199: Pb Concentration timeseries within the OB3 Water Treatment Study

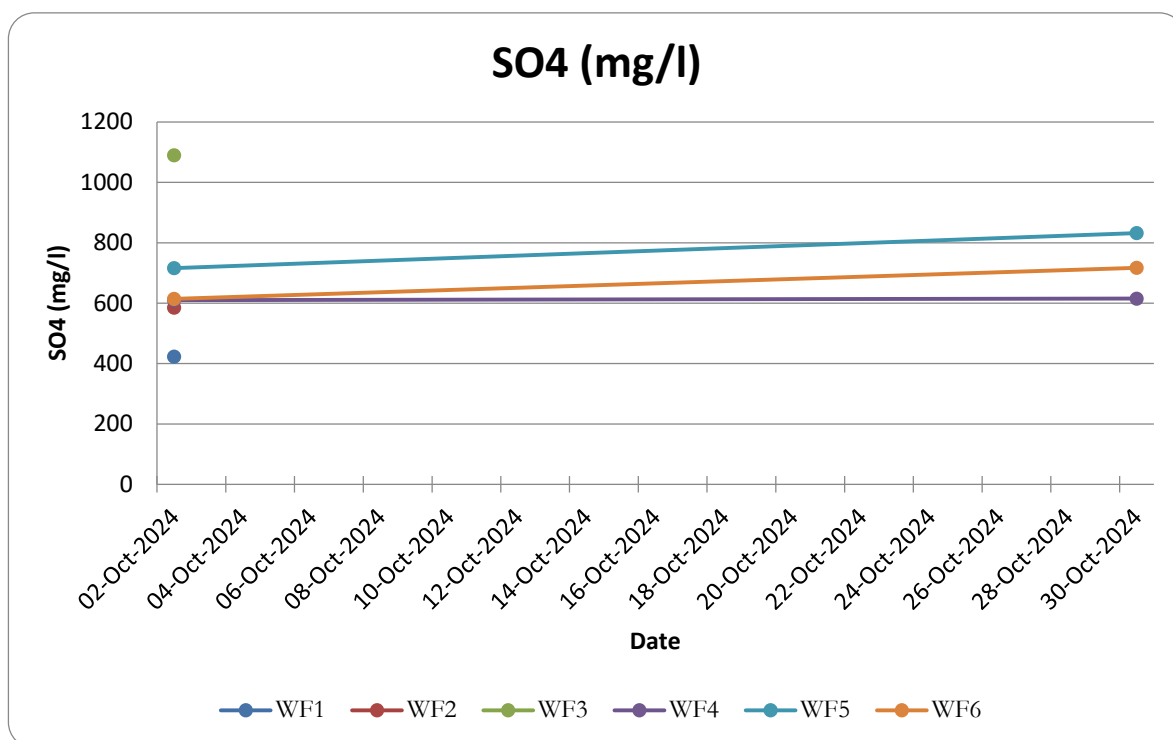


Figure 200: SO4 Concentration timeseries within the OB3 Water Treatment Study

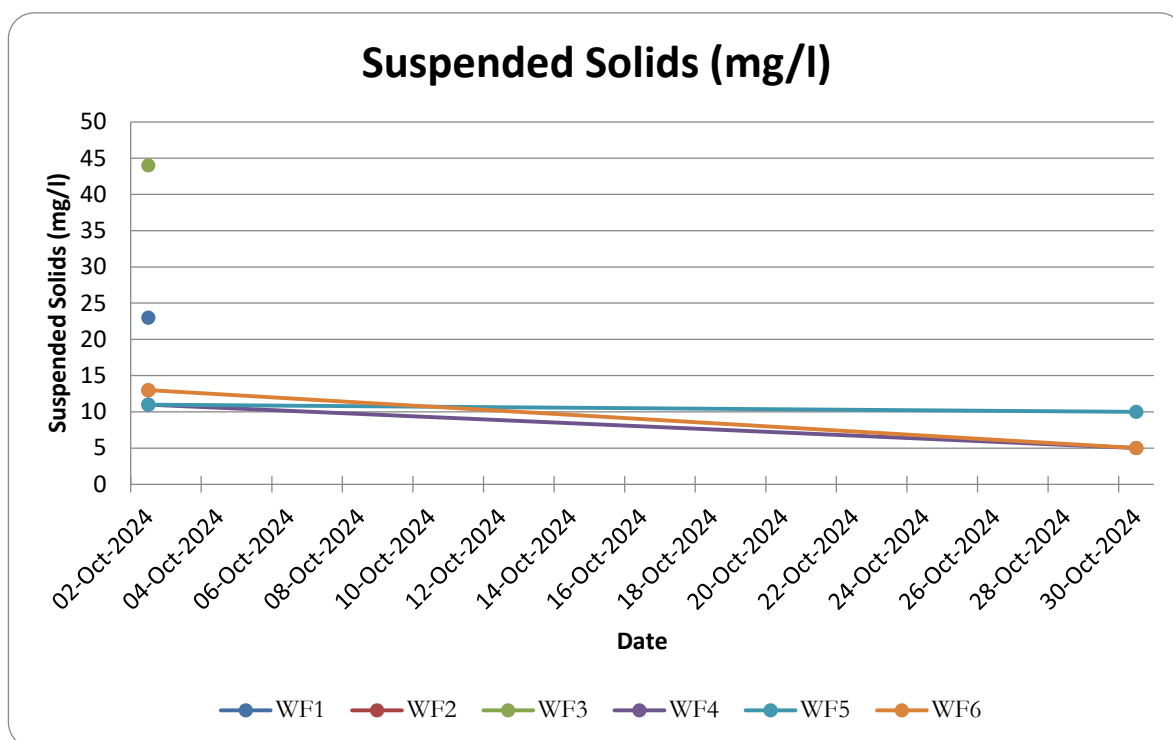


Figure 201: Suspended Solids Concentration timeseries within the OB3 Water Treatment Study

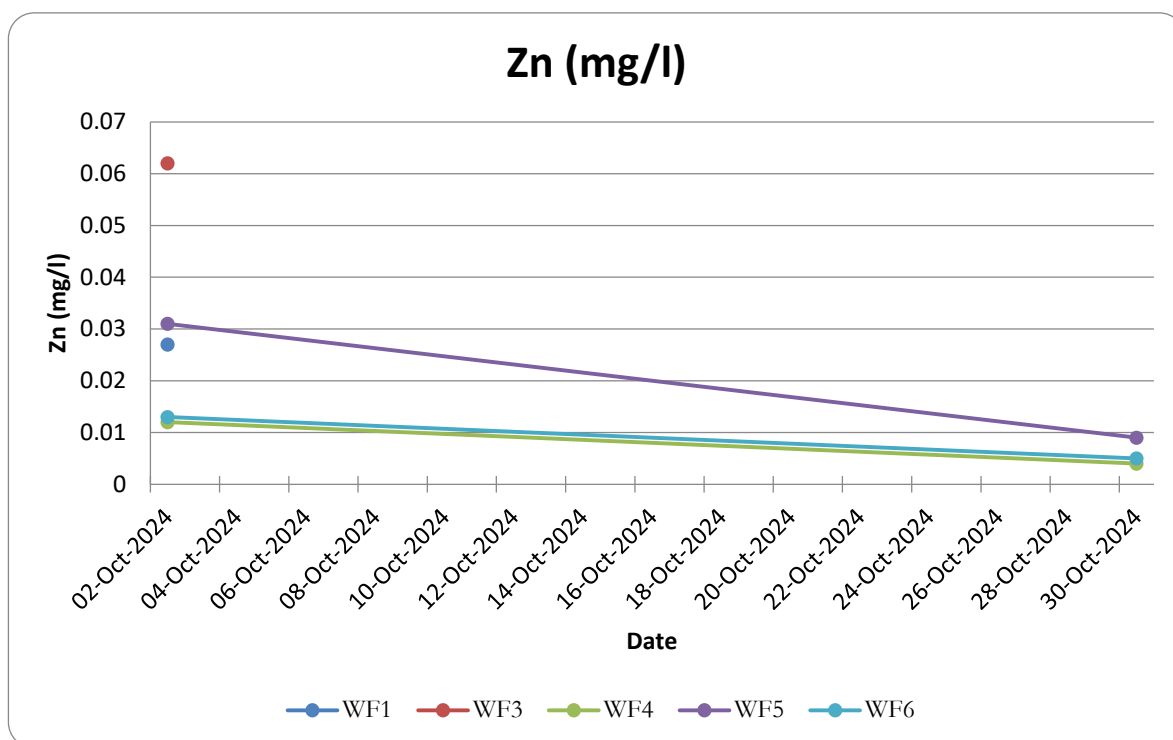


Figure 202: Zn Concentration timeseries within the OB3 Water Treatment Study

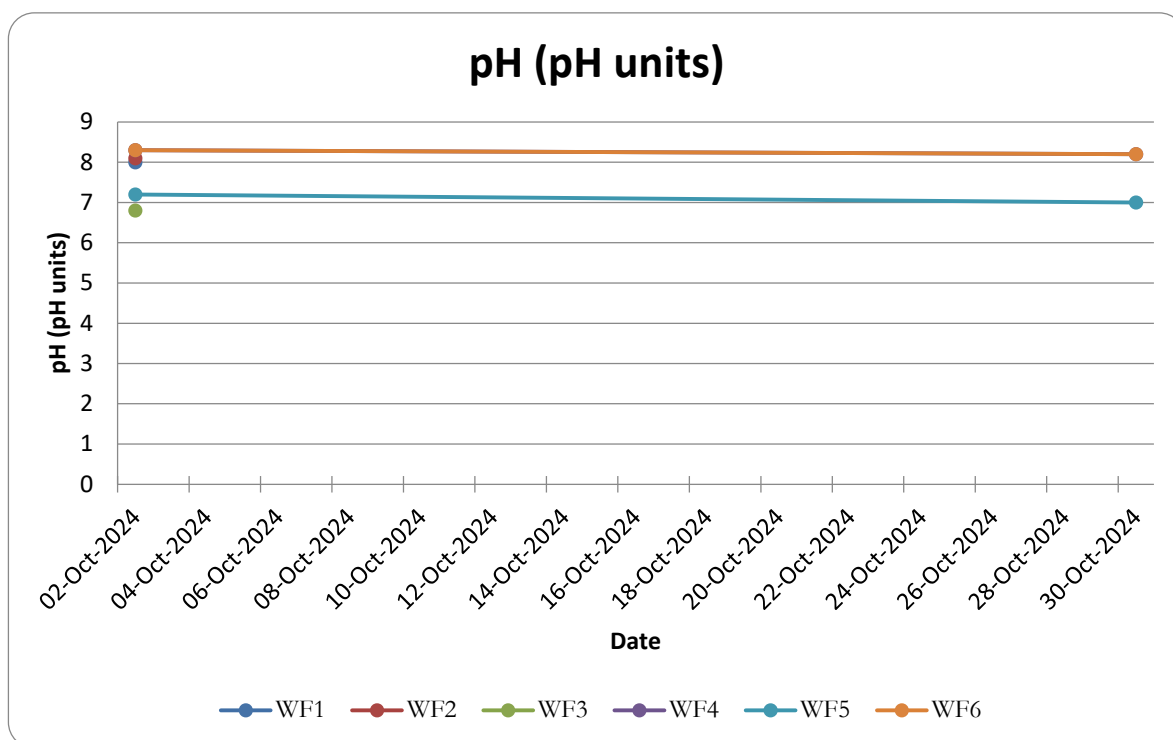


Figure 203: pH Concentration timeseries within the OB3 Water Treatment Study

## 12 POND

Table 14 Pond Monitoring Point Statistics

| Parameter    | Units | Stat  | MA11     | Rhas Las |
|--------------|-------|-------|----------|----------|
| Al           | mg/l  | min   | 0.01     | 0.09     |
|              |       | max   | 0.31     | 0.09     |
|              |       | mean  | 0.0787   | 0.09     |
|              |       | count | 49       | 2        |
| Alkalinity   | mg/l  | min   | 13       | 24.5     |
|              |       | max   | 93       | 24.5     |
|              |       | mean  | 26.6571  | 24.5     |
|              |       | count | 49       | 2        |
| As           | mg/l  | min   | 0.0002   | 0.001    |
|              |       | max   | 0.0014   | 0.001    |
|              |       | mean  | 0.0011   | 0.001    |
|              |       | count | 43       | 2        |
| Ca           | mg/l  | min   | 5        | 7        |
|              |       | max   | 17       | 7        |
|              |       | mean  | 7.88     | 7        |
|              |       | count | 49       | 2        |
| Cd           | mg/l  | min   | 0.00002  | 0.00003  |
|              |       | max   | 0.001    | 0.00003  |
|              |       | mean  | 0.000399 | 0.00003  |
|              |       | count | 43       | 2        |
| Cl           | mg/l  | min   | 3        | 6        |
|              |       | max   | 38       | 6        |
|              |       | mean  | 8.32     | 6        |
|              |       | count | 49       | 2        |
| Conductivity | mS/cm | min   | 57.4     | 0.1      |
|              |       | max   | 211      | 0.1      |
|              |       | mean  | 78.561   | 0.1      |
|              |       | count | 49       | 2        |
| Cr           | mg/l  | min   | 0.001    | 0.001    |
|              |       | max   | 0.002    | 0.001    |
|              |       | mean  | 0.00163  | 0.001    |
|              |       | count | 43       | 2        |
| Cu           | mg/l  | min   | 0.0005   | 0.002    |
|              |       | max   | 0.146    | 0.002    |
|              |       | mean  | 0.00934  | 0.002    |
|              |       | count | 49       | 2        |
| Fe           | mg/l  | min   | 0.005    | 0.17     |
|              |       | max   | 5.76     | 0.17     |
|              |       | mean  | 0.3047   | 0.17     |
|              |       | count | 49       | 2        |
| Hg           | mg/l  | min   | 0.00005  | 0.00003  |
|              |       | max   | 0.0001   | 0.00003  |
|              |       | mean  | 8.49E-05 | 0.00003  |
|              |       | count | 43       | 2        |
| K            | mg/l  | min   | 0        | 1        |
|              |       | max   | 2        | 1        |
|              |       | mean  | 1.1      | 1        |
|              |       | count | 49       | 2        |
| Mg           | mg/l  | min   | 1        | 1        |
|              |       | max   | 3        | 1        |
|              |       | mean  | 1.2      | 1        |
|              |       | count | 49       | 2        |



| Parameter        | Units    | Stat  | MA11     | Rhas Las |
|------------------|----------|-------|----------|----------|
| Mn               | mg/l     | min   | 0.001    |          |
|                  |          | max   | 0.205    |          |
|                  |          | mean  | 0.01404  |          |
|                  |          | count | 49       |          |
| Mo               | mg/l     | min   | 0.001    | 0.001    |
|                  |          | max   | 0.062    | 0.001    |
|                  |          | mean  | 0.00465  | 0.001    |
|                  |          | count | 43       | 2        |
| N                | mg/l     | min   | 0.1      |          |
|                  |          | max   | 16.2     |          |
|                  |          | mean  | 0.6837   |          |
|                  |          | count | 49       |          |
| NH3 (as N)       | mg/l     | min   | 0.01     | 0.09     |
|                  |          | max   | 0.56     | 0.09     |
|                  |          | mean  | 0.2231   | 0.09     |
|                  |          | count | 49       | 2        |
| Na               | mg/l     | min   | 2        | 2        |
|                  |          | max   | 20       | 2        |
|                  |          | mean  | 4.27     | 2        |
|                  |          | count | 49       | 2        |
| Ni               | mg/l     | min   | 0.001    | 0.002    |
|                  |          | max   | 0.712    | 0.002    |
|                  |          | mean  | 0.01907  | 0.002    |
|                  |          | count | 43       | 2        |
| Pb               | mg/l     | min   | 0.0003   | 0.001    |
|                  |          | max   | 0.007    | 0.001    |
|                  |          | mean  | 0.00417  | 0.001    |
|                  |          | count | 49       | 2        |
| SO4              | mg/l     | min   | 1        | 3        |
|                  |          | max   | 9        | 3        |
|                  |          | mean  | 4.1      | 3        |
|                  |          | count | 49       | 2        |
| Se               | mg/l     | min   | 0.0005   | 0.001    |
|                  |          | max   | 0.0025   | 0.001    |
|                  |          | mean  | 0.001273 | 0.001    |
|                  |          | count | 49       | 2        |
| Suspended Solids | mg/l     | min   | 1        | 5        |
|                  |          | max   | 93       | 5        |
|                  |          | mean  | 15.08    | 5        |
|                  |          | count | 49       | 2        |
| Zn               | mg/l     | min   | 0.002    | 0.016    |
|                  |          | max   | 0.032    | 0.016    |
|                  |          | mean  | 0.01516  | 0.016    |
|                  |          | count | 49       | 2        |
| pH               | pH units | min   | 6.1      | 7.4      |
|                  |          | max   | 8.1      | 7.4      |
|                  |          | mean  | 7.392    | 7.4      |
|                  |          | count | 49       | 2        |

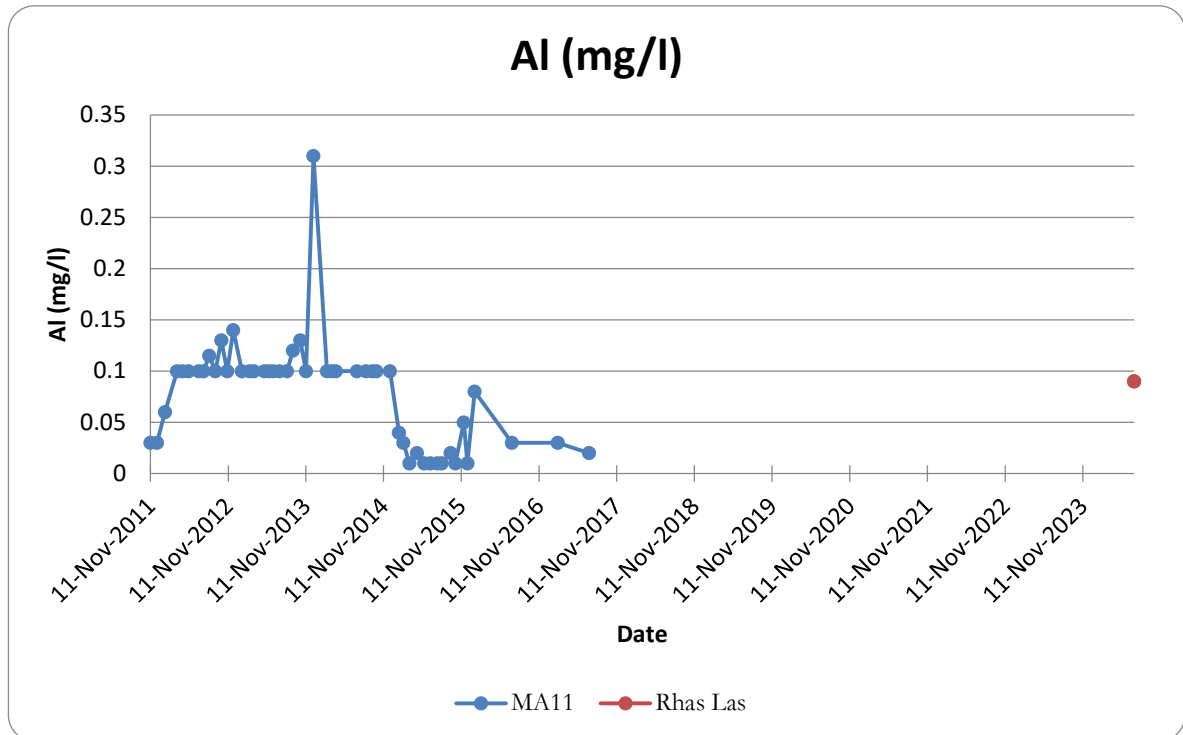


Figure 204: Al Concentration timeseries within the Pond

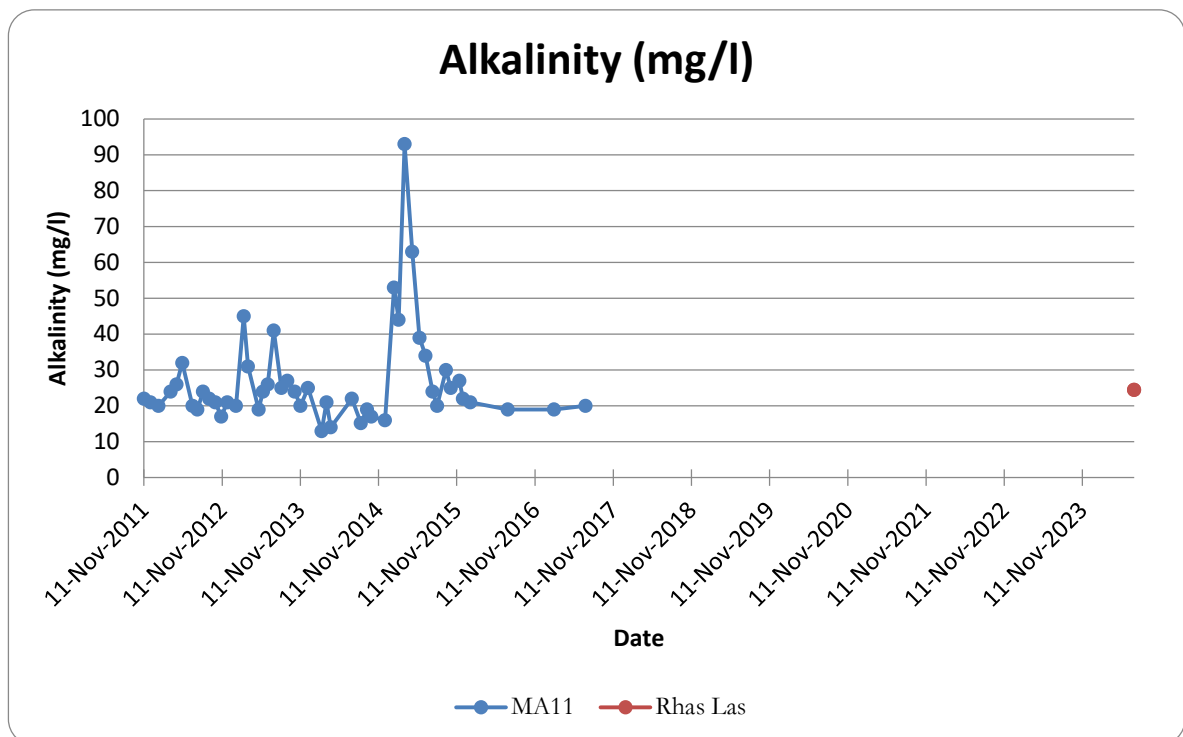


Figure 205: Alkalinity Concentration timeseries within the Pond

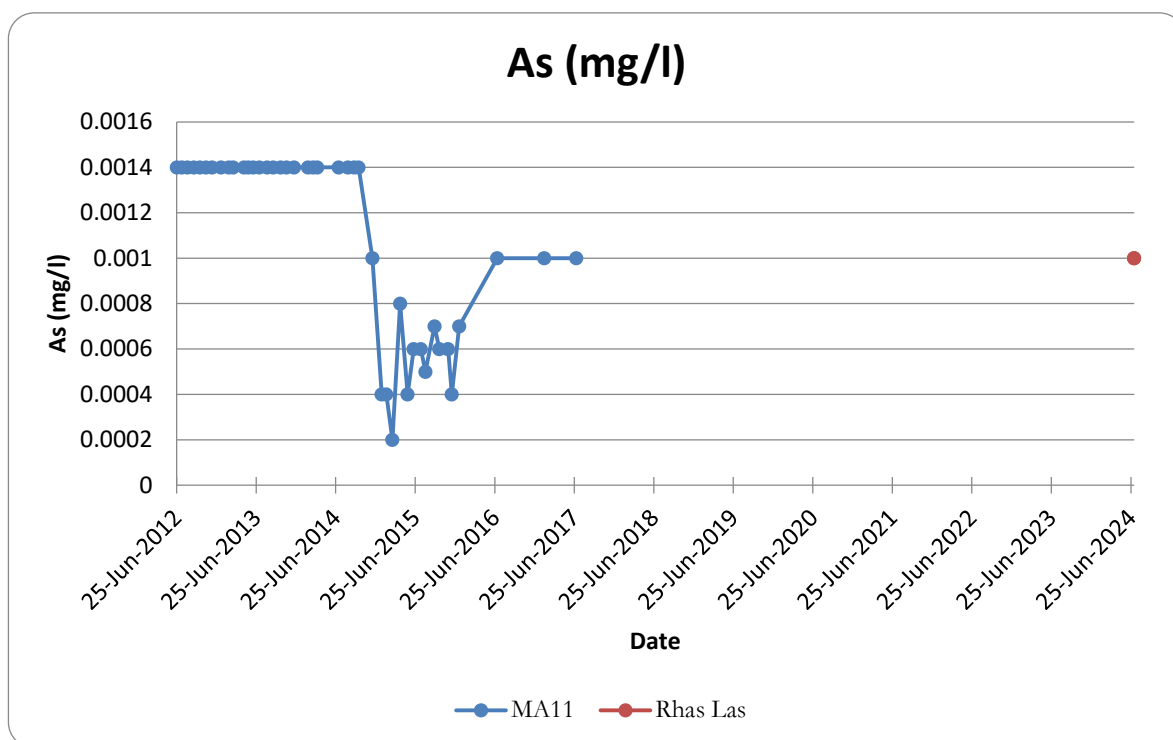


Figure 206: As Concentration timeseries within the Pond

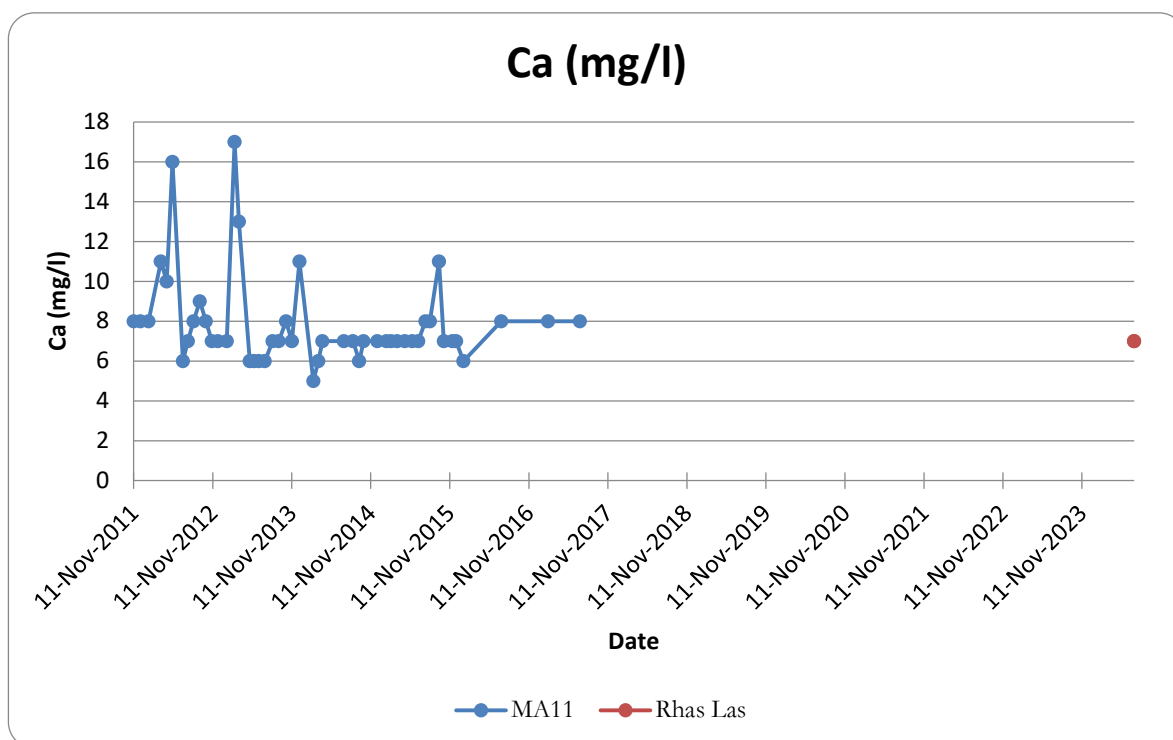


Figure 207: Ca Concentration timeseries within the Pond

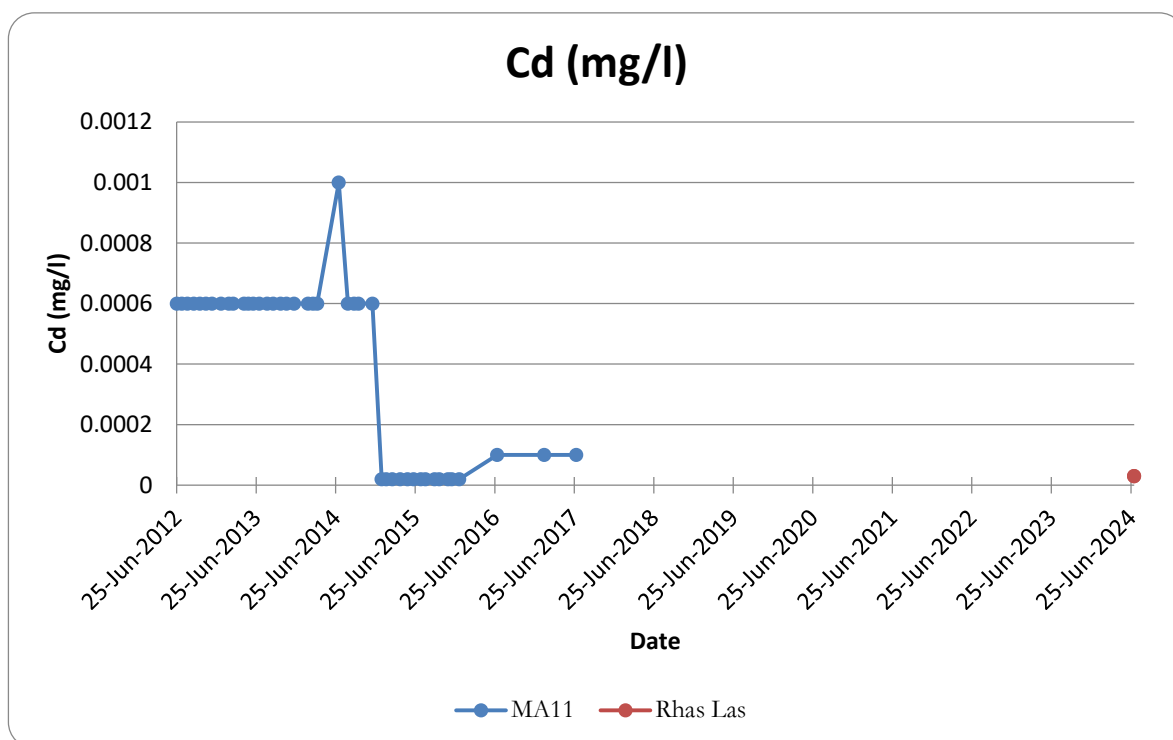


Figure 208: Cd Concentration timeseries within the Pond

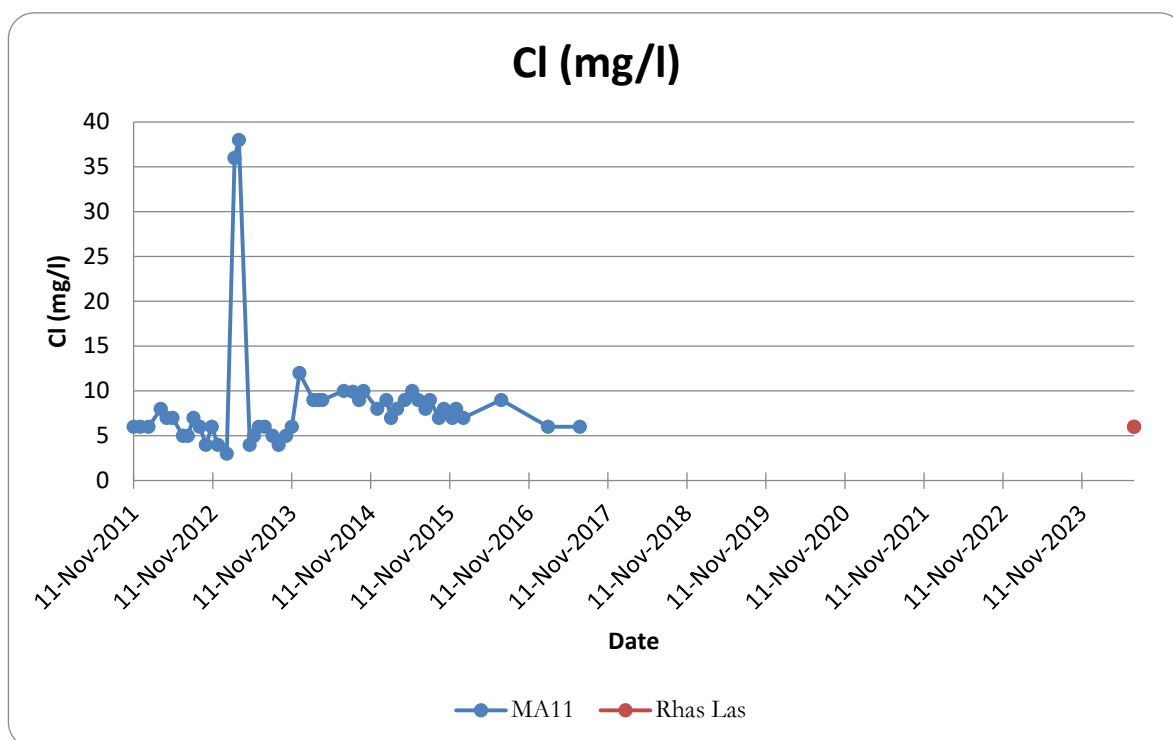


Figure 209: Cl Concentration timeseries within the Pond

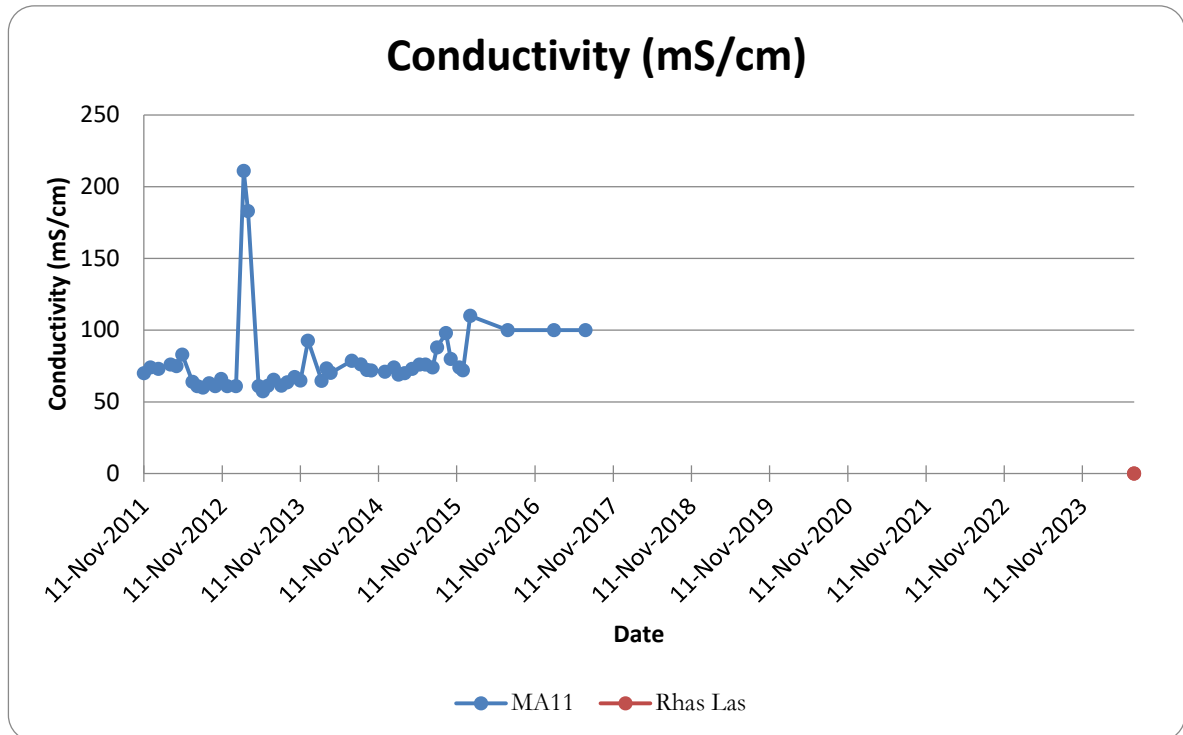


Figure 210: Electrical Conductivity timeseries within the Pond

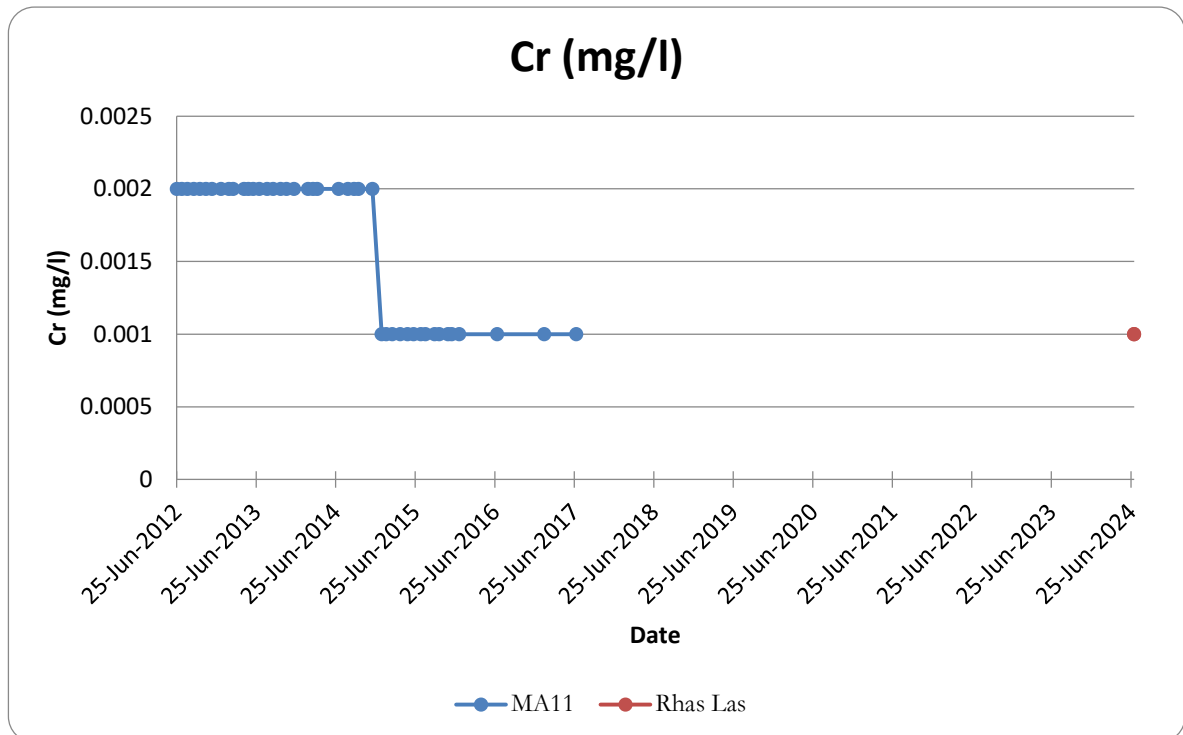


Figure 211:Cr Concentration timeseries within the Pond

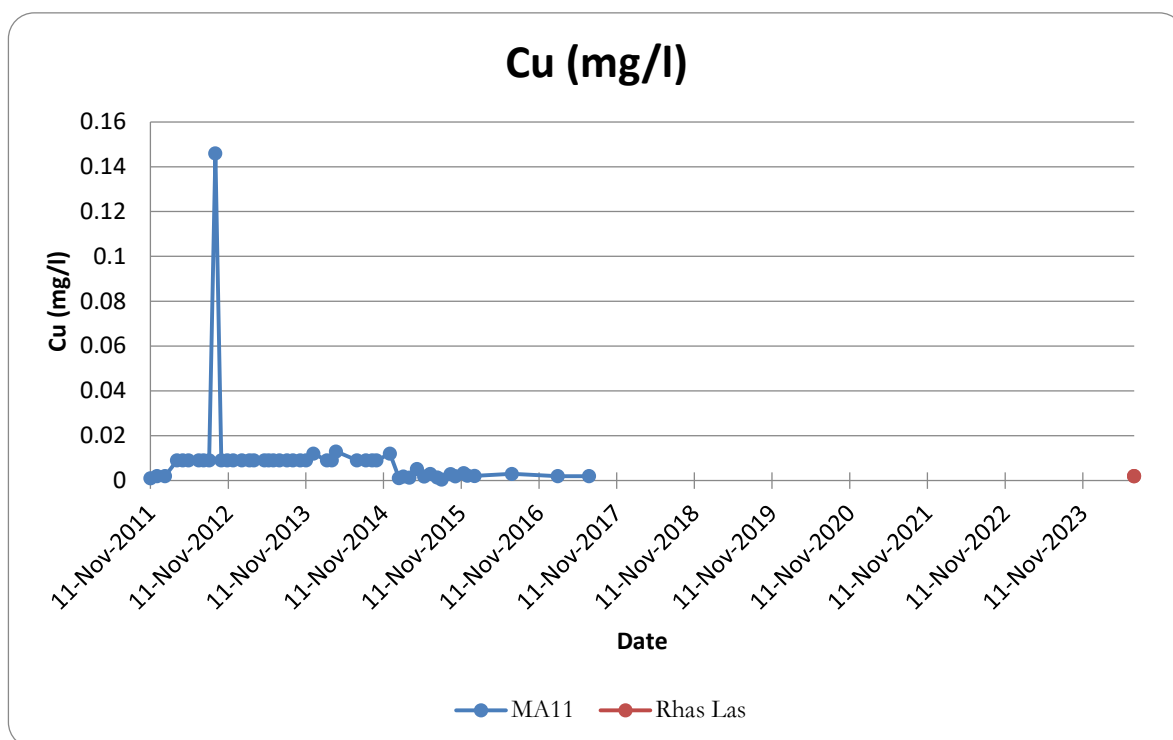


Figure 212: Cu Concentration timeseries within the Pond

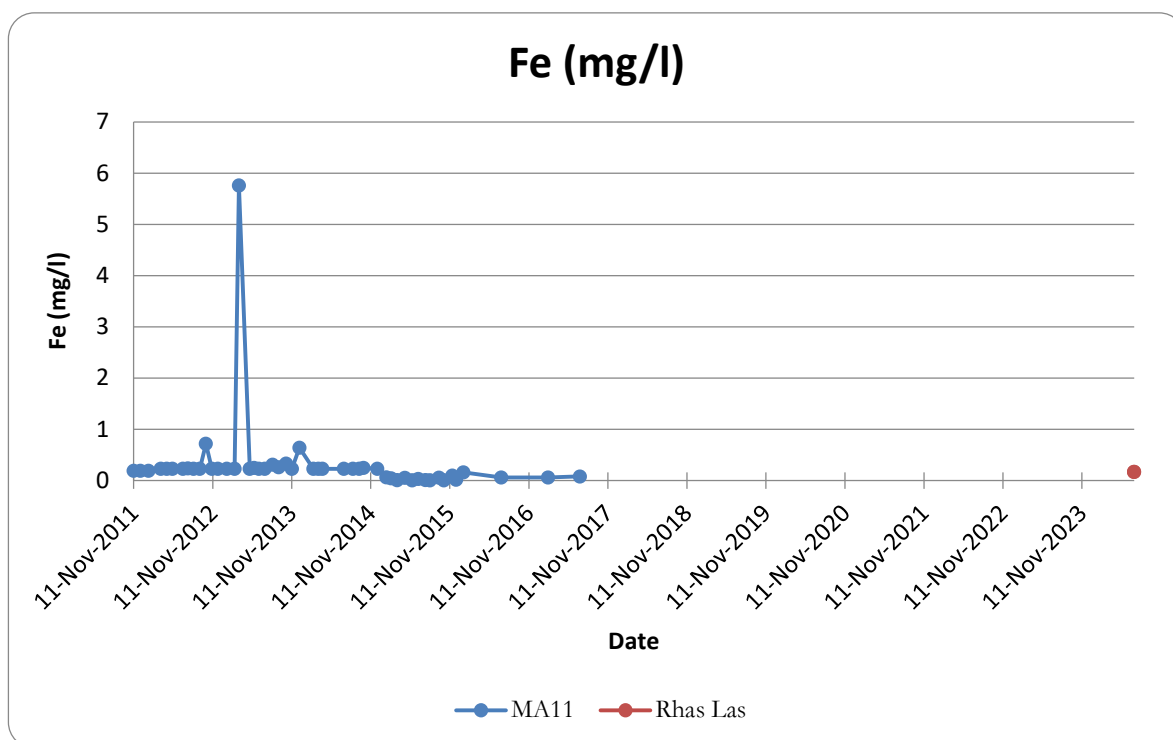


Figure 213: Fe Concentration timeseries within the Pond

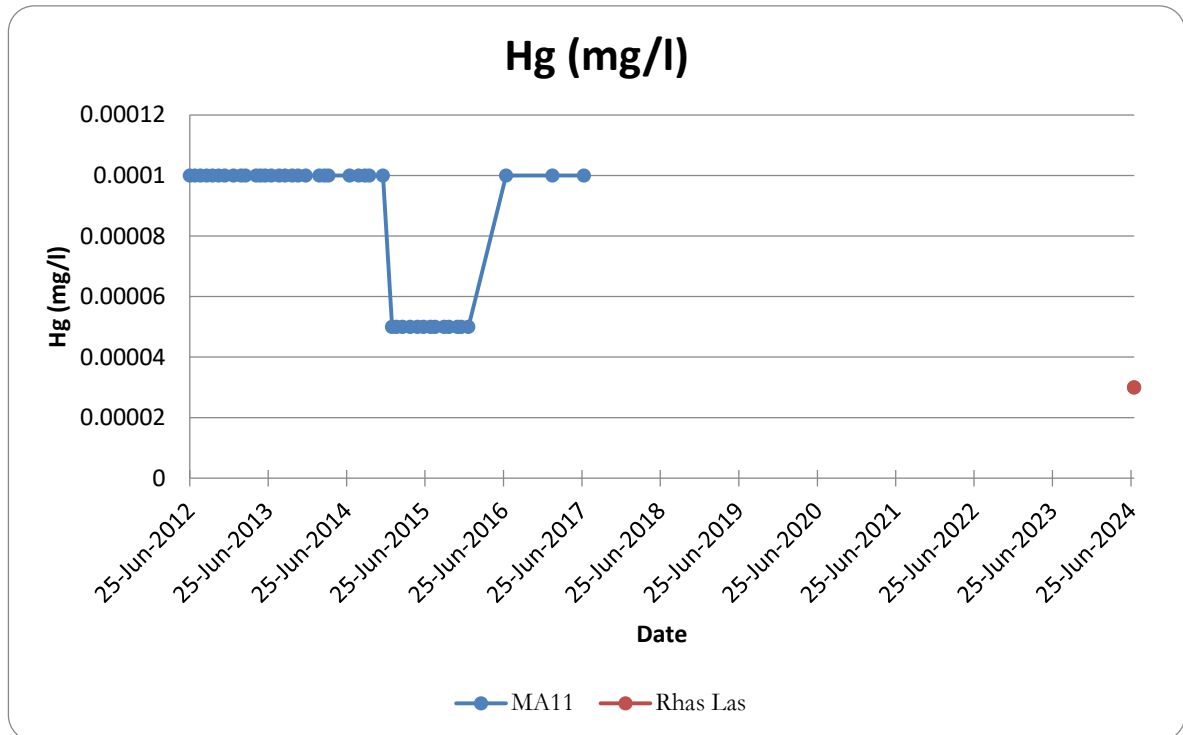


Figure 214: Hg Concentration timeseries within the Pond

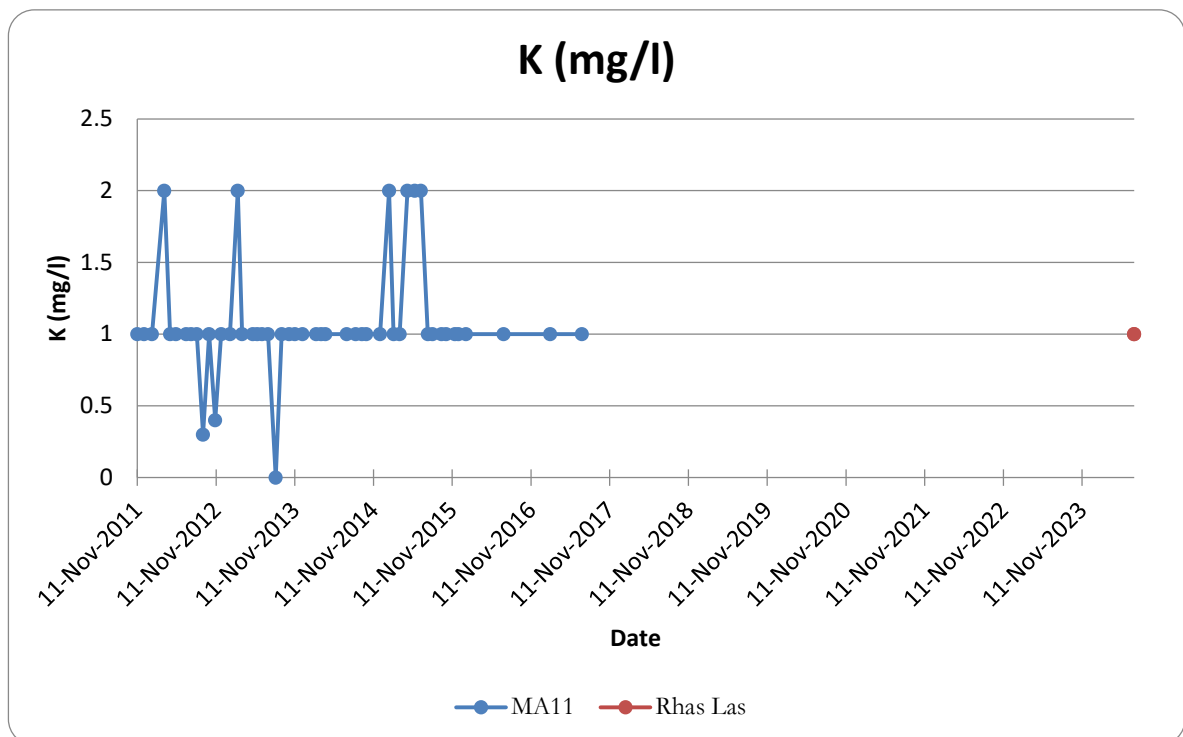


Figure 215: K Concentration timeseries within the Pond

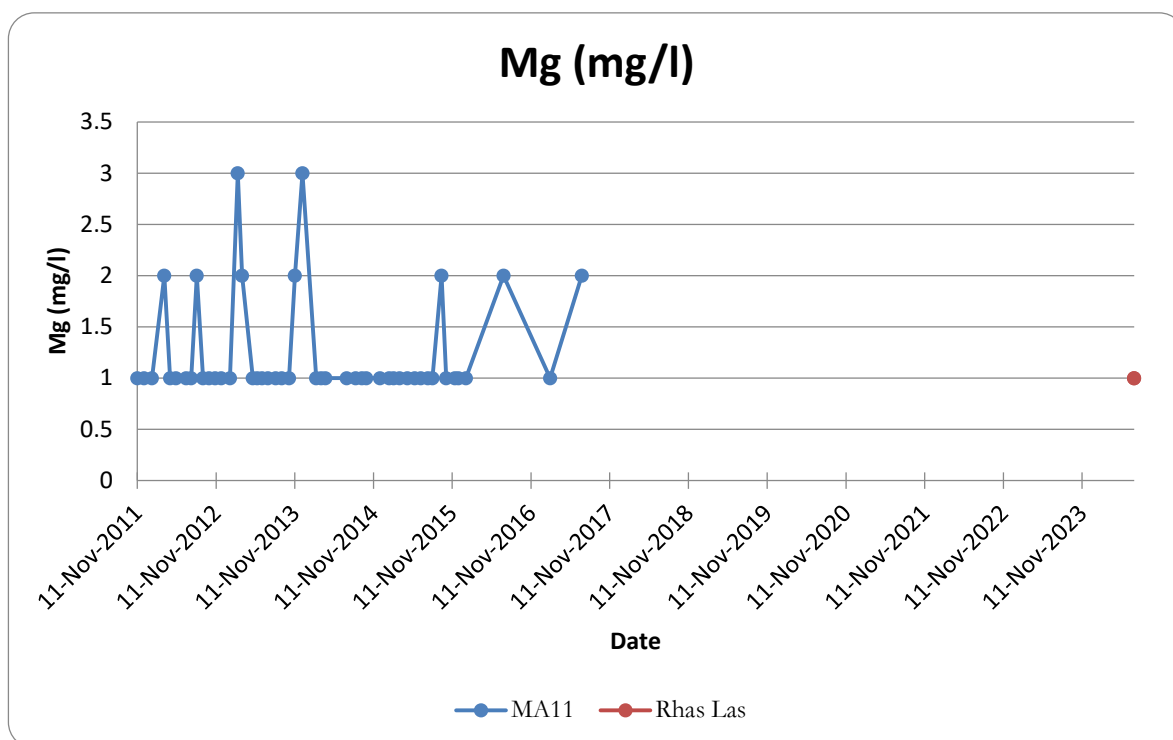


Figure 216: Mg Concentration timeseries within the Pond

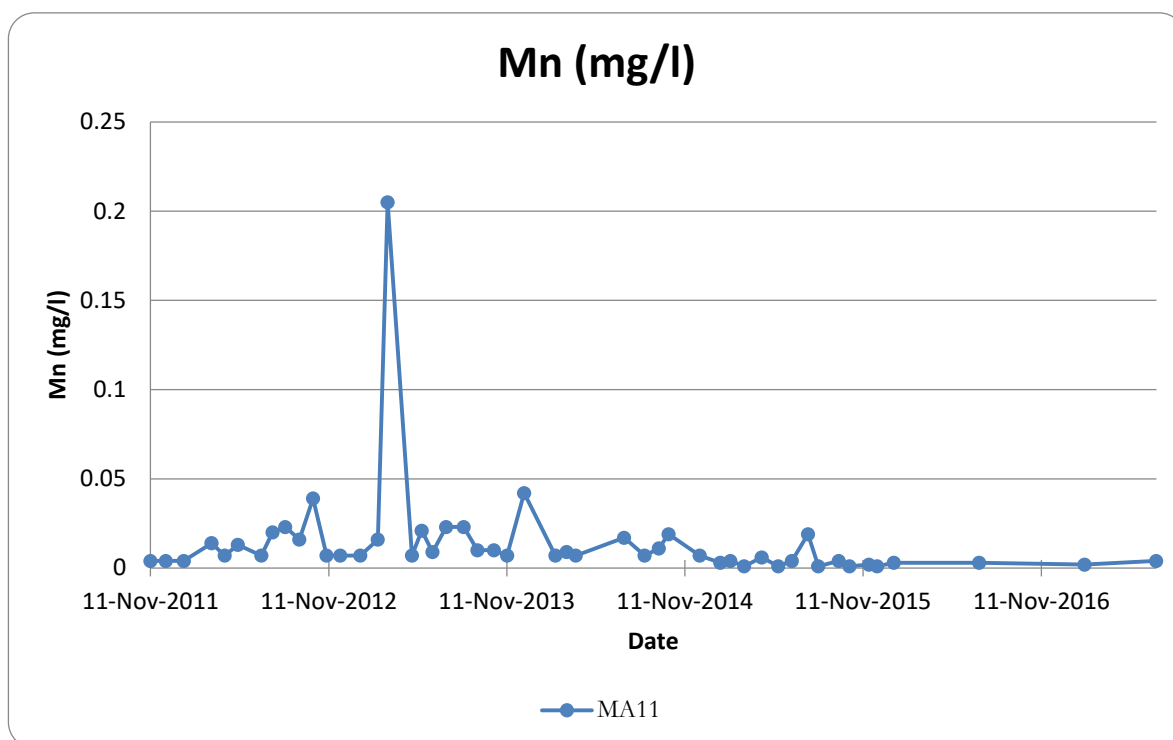


Figure 217: Mn Concentration timeseries within the Pond

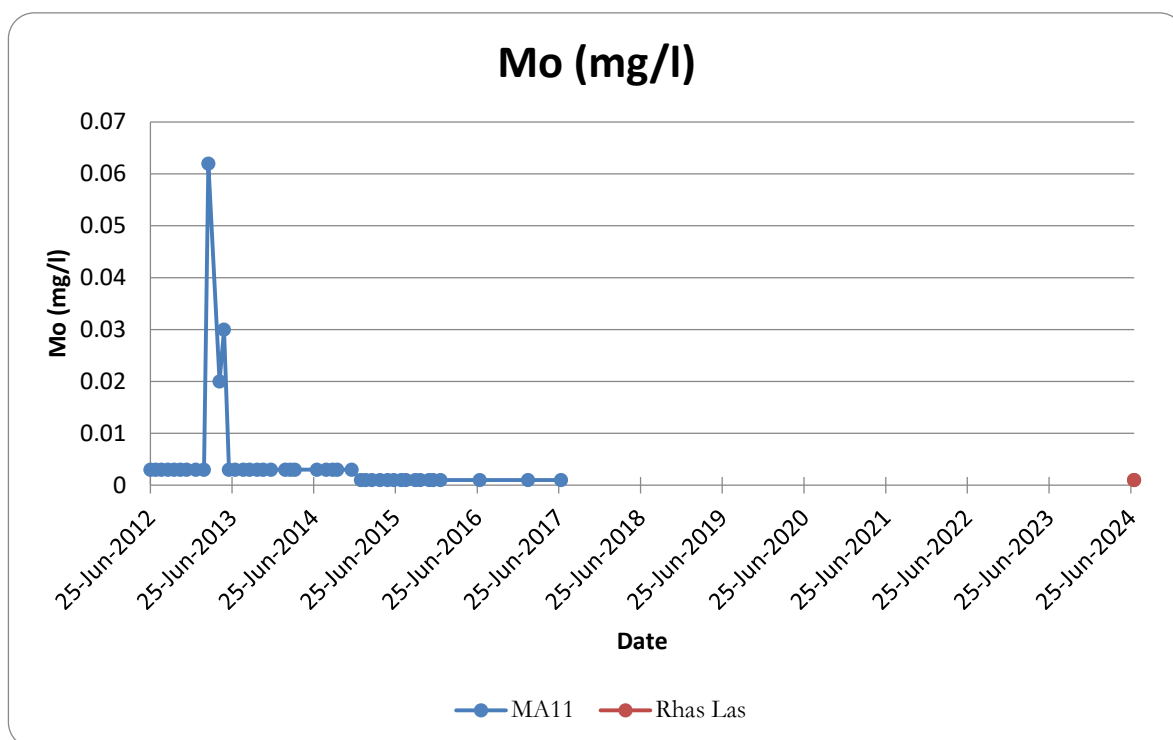


Figure 218: Mo Concentration timeseries within the Pond

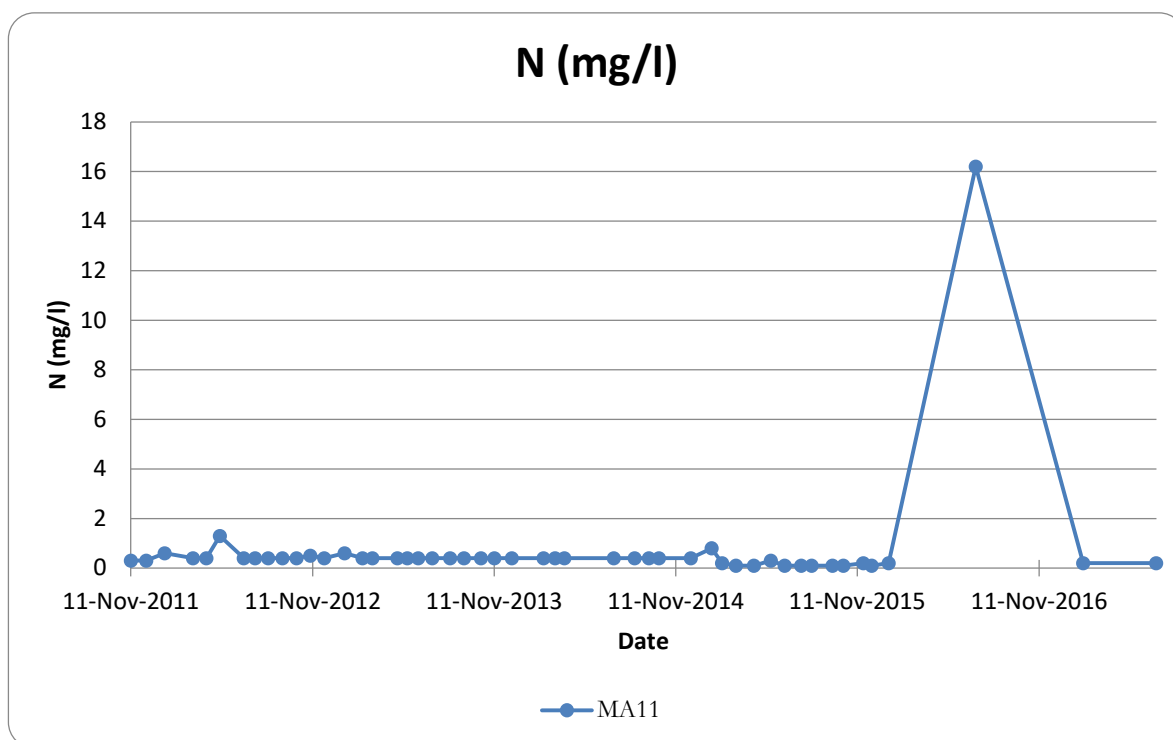


Figure 219: N Concentration timeseries within the Pond

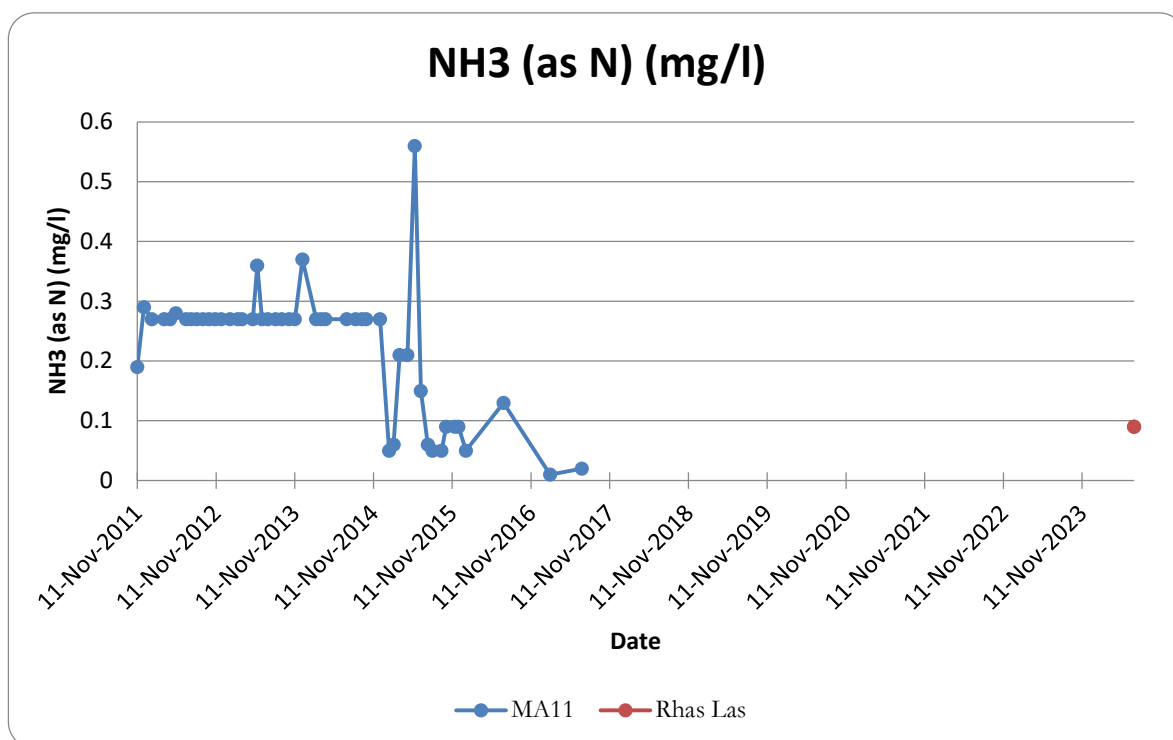


Figure 220: NH3 (as N) Concentration timeseries within the Pond

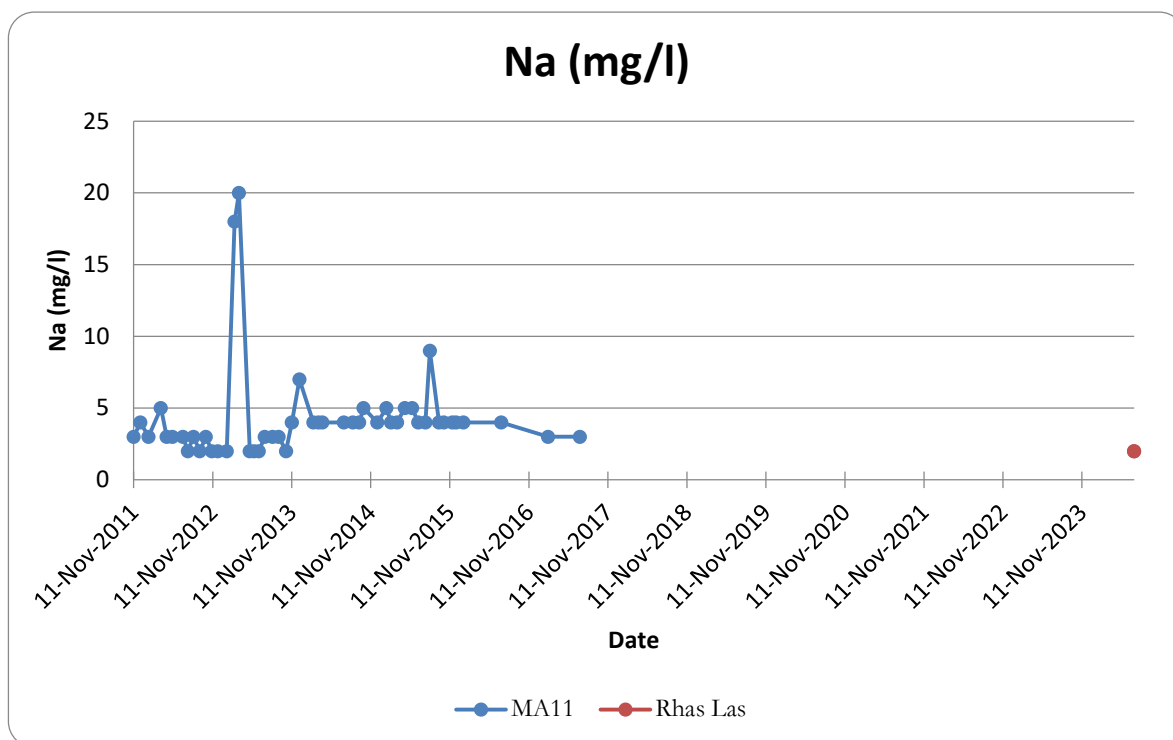


Figure 221: Na Concentration timeseries within the Pond

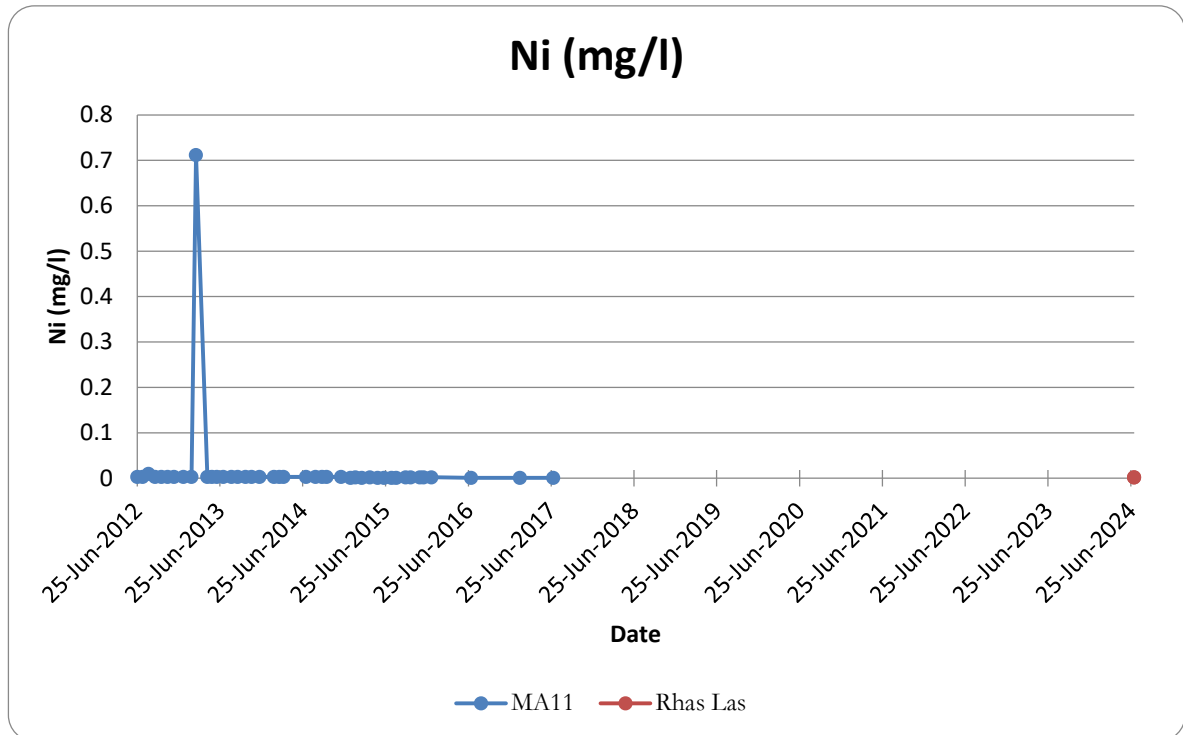


Figure 222: Ni Concentration timeseries within the Pond

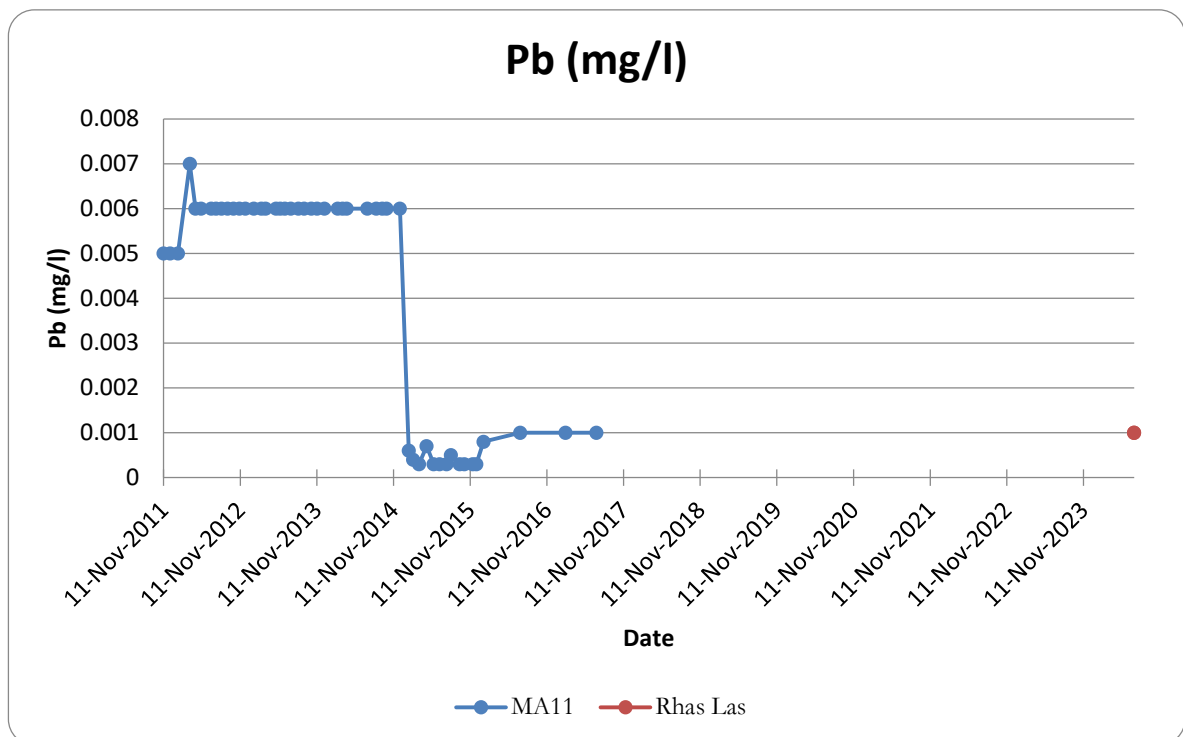


Figure 223: Pb Concentration timeseries within the Pond



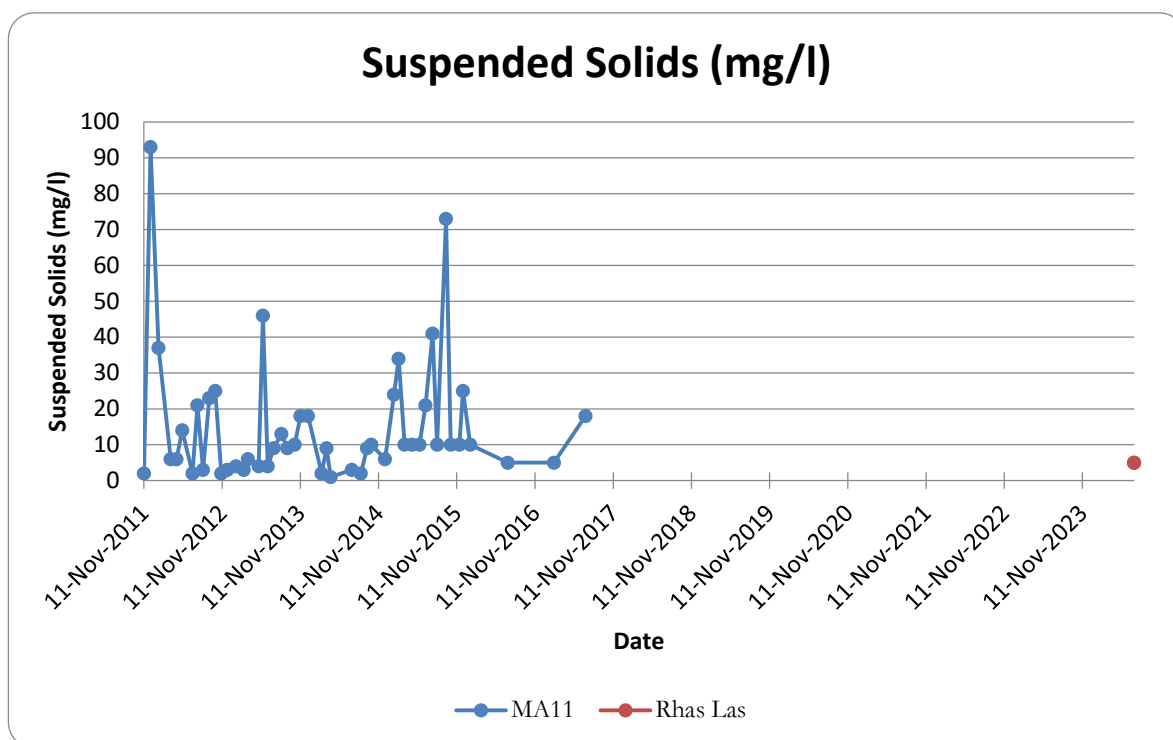


Figure 226: Suspended Solids Concentration timeseries within the Pond

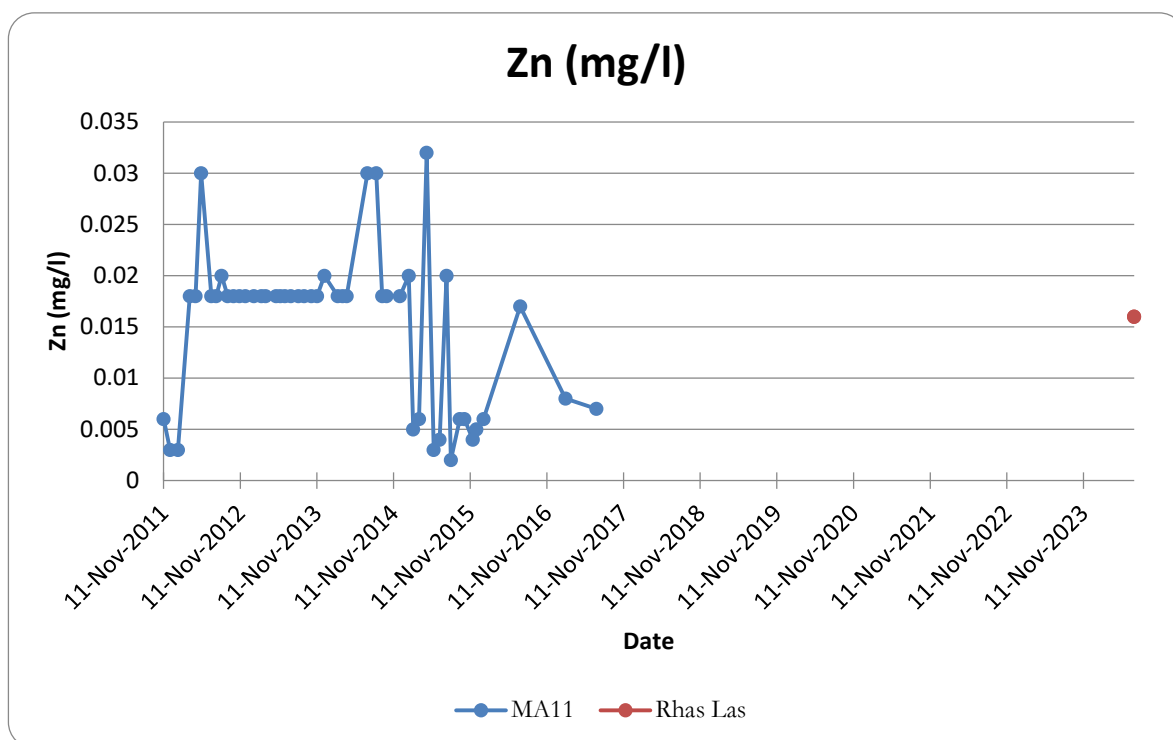


Figure 227: Zn Concentration timeseries within the Pond

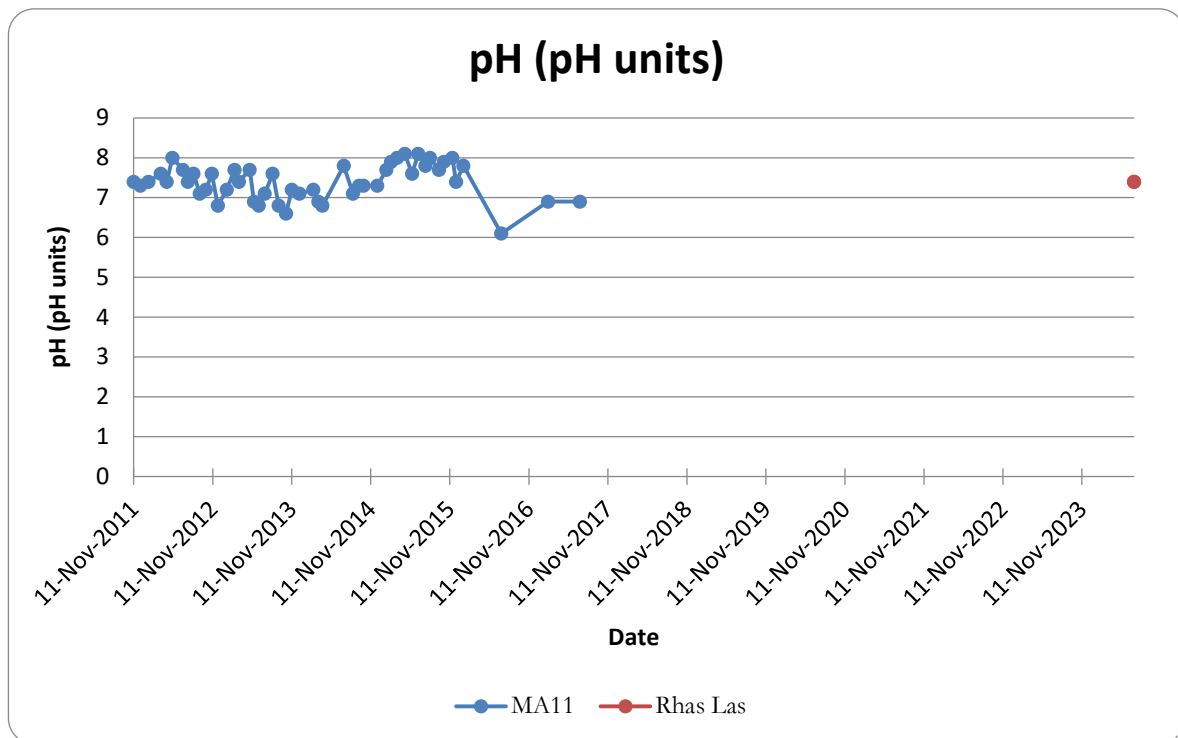


Figure 228: pH Concentration timeseries within the Pond

## 13 RIVER

Table 15 River Monitoring Point Statistics (BF, MA07 to MA12)

| Parameter    | Units | Stat  | BF       | MA07     | MA08     | MA10     | MA12     |
|--------------|-------|-------|----------|----------|----------|----------|----------|
| Al           | mg/l  | min   | 0.005    | 0        | 0.008    | 0        | 0.01     |
|              |       | max   | 0.61     | 0.693    | 0.698    | 0.67     | 1.68     |
|              |       | mean  | 0.13188  | 0.08658  | 0.07617  | 0.07213  | 0.13976  |
|              |       | count | 16       | 77       | 75       | 108      | 42       |
| Alkalinity   | mg/l  | min   | 25       | 7.6      | 21.4     | 22       | 22       |
|              |       | max   | 160      | 291      | 219      | 381      | 81       |
|              |       | mean  | 89.344   | 95.461   | 122.087  | 124.317  | 44.595   |
|              |       | count | 16       | 70       | 68       | 102      | 42       |
| As           | mg/l  | min   | 0.0003   | 0.0003   | 0.0004   | 0.0005   | 0.0006   |
|              |       | max   | 0.0014   | 0.01     | 0.01     | 0.01     | 0.0025   |
|              |       | mean  | 0.001056 | 0.00158  | 0.001566 | 0.001478 | 0.001291 |
|              |       | count | 16       | 55       | 53       | 81       | 35       |
| Ca           | mg/l  | min   | 15.8     | 0        | 0.4      | 8        | 9        |
|              |       | max   | 81       | 130      | 140      | 110      | 31       |
|              |       | mean  | 44.5     | 49.784   | 73.19    | 38.055   | 16.214   |
|              |       | count | 16       | 79       | 77       | 110      | 42       |
| Cd           | mg/l  | min   | 0.00002  | 0        | 0        | 0        | 0.00002  |
|              |       | max   | 0.0006   | 0.002    | 0.002    | 0.002    | 0.0006   |
|              |       | mean  | 0.000385 | 0.000355 | 0.000336 | 0.000355 | 0.000374 |
|              |       | count | 16       | 55       | 53       | 82       | 35       |
| Cl           | mg/l  | min   | 8.31     | 6        | 0.1      | 4        | 7        |
|              |       | max   | 27       | 91       | 42       | 126      | 74       |
|              |       | mean  | 12.548   | 17.766   | 12.836   | 19.321   | 28.81    |
|              |       | count | 16       | 77       | 76       | 109      | 42       |
| Conductivity | mS/cm | min   | 150      | 0.372    | 0.484    | 0.142    | 89.3     |
|              |       | max   | 880      | 1170     | 1400     | 1220     | 356      |
|              |       | mean  | 507.5625 | 519.5388 | 750.4883 | 358.0031 | 191.8405 |
|              |       | count | 16       | 73       | 71       | 104      | 42       |
| Cr           | mg/l  | min   | 0.001    | 0        | 0.001    | 0.001    | 0.001    |
|              |       | max   | 0.005    | 0.01     | 59       | 0.01     | 0.007    |
|              |       | mean  | 0.002    | 0.00175  | 1.11513  | 0.00174  | 0.00186  |
|              |       | count | 16       | 55       | 53       | 81       | 35       |
| Cu           | mg/l  | min   | 0.0013   | 0        | 0        | 0        | 0.0005   |
|              |       | max   | 0.01     | 0.016    | 0.01     | 0.016    | 0.01     |
|              |       | mean  | 0.006413 | 0.004167 | 0.00375  | 0.004663 | 0.006245 |
|              |       | count | 16       | 78       | 76       | 109      | 42       |
| Fe           | mg/l  | min   | 0.007    | 0        | 0        | 0.01     | 0.015    |
|              |       | max   | 1.72     | 11.1     | 7.78     | 2.14     | 2.47     |
|              |       | mean  | 0.32019  | 0.67873  | 0.38879  | 0.42648  | 0.43612  |
|              |       | count | 16       | 78       | 76       | 109      | 42       |
| Hg           | mg/l  | min   | 0.00005  | 0.00003  | 0.00003  | 0.00003  | 0.00005  |
|              |       | max   | 0.0006   | 0.002    | 0.001    | 0.001    | 0.00045  |
|              |       | mean  | 0.000119 | 0.000157 | 0.000145 | 0.000108 | 9.46E-05 |
|              |       | count | 16       | 55       | 53       | 81       | 35       |
| K            | mg/l  | min   | 1        | 0        | 2        | 1        | 1        |
|              |       | max   | 19       | 26       | 36       | 44       | 3        |
|              |       | mean  | 9.81     | 11.24    | 16.37    | 8.85     | 1.76     |
|              |       | count | 16       | 78       | 76       | 110      | 42       |
| Mg           | mg/l  | min   | 3        | 1        | 0.82     | 2        | 2        |
|              |       | max   | 63       | 90       | 110      | 92       | 16       |
|              |       | mean  | 34.233   | 32.752   | 53.965   | 19.527   | 3.452    |
|              |       | count | 15       | 79       | 77       | 110      | 42       |

| Parameter        | Units    | Stat  | BF       | MA07     | MA08     | MA10    | MA12     |
|------------------|----------|-------|----------|----------|----------|---------|----------|
| Mn               | mg/l     | min   | 0.001    | 0.006    | 0.001    | 0.001   | 0.001    |
|                  |          | max   | 0.266    | 1.633    | 1.16     | 0.52    | 0.233    |
|                  |          | mean  | 0.06938  | 0.21666  | 0.18785  | 0.0839  | 0.03669  |
|                  |          | count | 16       | 68       | 68       | 100     | 42       |
| Mo               | mg/l     | min   | 0.001    | 0.001    | 0.001    | 0.001   | 0.001    |
|                  |          | max   | 0.127    | 0.127    | 0.13     | 0.048   | 0.038    |
|                  |          | mean  | 0.01088  | 0.00463  | 0.0044   | 0.00275 | 0.00377  |
|                  |          | count | 16       | 52       | 50       | 79      | 35       |
| N                | mg/l     | min   | 0.1      | 0        | 0        | 0       | 0.1      |
|                  |          | max   | 0.95     | 2.1      | 2        | 12.2    | 5.2      |
|                  |          | mean  | 0.4531   | 0.6187   | 0.5593   | 0.6713  | 0.5048   |
|                  |          | count | 16       | 69       | 70       | 101     | 42       |
| NH3 (as N)       | mg/l     | min   | 0.05     | 0        | 0        | 0.01    | 0.01     |
|                  |          | max   | 0.27     | 1.4      | 1.3      | 0.6     | 1.18     |
|                  |          | mean  | 0.2144   | 0.1583   | 0.1322   | 0.1519  | 0.245    |
|                  |          | count | 16       | 79       | 77       | 110     | 42       |
| Na               | mg/l     | min   | 6        | 0        | 0.03     | 4       | 4        |
|                  |          | max   | 16       | 52       | 85       | 66      | 41       |
|                  |          | mean  | 10.62    | 13.04    | 15.55    | 16.82   | 16.05    |
|                  |          | count | 16       | 79       | 77       | 110     | 42       |
| Ni               | mg/l     | min   | 0.001    | 0        | 0        | 0       | 0.001    |
|                  |          | max   | 0.018    | 0.143    | 513      | 0.224   | 0.337    |
|                  |          | mean  | 0.00706  | 0.01809  | 9.51374  | 0.00644 | 0.01323  |
|                  |          | count | 16       | 55       | 54       | 82      | 35       |
| Pb               | mg/l     | min   | 0.0003   | 0.0001   | 0.0001   | 0       | 0.0003   |
|                  |          | max   | 0.01     | 0.006    | 0.006    | 0.008   | 0.009    |
|                  |          | mean  | 0.004113 | 0.002214 | 0.00222  | 0.00291 | 0.00431  |
|                  |          | count | 16       | 78       | 76       | 109     | 42       |
| SO4              | mg/l     | min   | 10       | 20       | 0.01     | 5       | 3        |
|                  |          | max   | 318      | 479      | 643      | 360     | 24       |
|                  |          | mean  | 174.313  | 178.718  | 302.429  | 67.427  | 8.881    |
|                  |          | count | 16       | 78       | 77       | 110     | 42       |
| Se               | mg/l     | min   | 0.0005   | 0.0001   | 0.001    | 0.0001  | 0.0005   |
|                  |          | max   | 0.0031   | 0.393    | 0.183    | 0.002   | 0.008    |
|                  |          | mean  | 0.001631 | 0.0074   | 0.004904 | 0.00117 | 0.001393 |
|                  |          | count | 16       | 72       | 70       | 103     | 42       |
| Suspended Solids | mg/l     | min   | 1        | 2        | 2        | 1       | 1        |
|                  |          | max   | 47       | 481      | 439      | 81      | 288      |
|                  |          | mean  | 13.25    | 22.38    | 19.39    | 10.436  | 23.543   |
|                  |          | count | 16       | 79       | 77       | 110     | 42       |
| Zn               | mg/l     | min   | 0.003    | 0        | 0        | 0       | 0.004    |
|                  |          | max   | 0.16     | 0.159    | 0.107    | 0.058   | 0.049    |
|                  |          | mean  | 0.03188  | 0.01646  | 0.01372  | 0.01338 | 0.01771  |
|                  |          | count | 16       | 78       | 76       | 109     | 42       |
| pH               | pH units | min   | 7.4      | 3.1      | 6.5      | 6.7     | 6.8      |
|                  |          | max   | 8.3      | 8.4      | 8.5      | 8.4     | 8.3      |
|                  |          | mean  | 7.888    | 7.624    | 7.865    | 7.524   | 7.645    |
|                  |          | count | 16       | 80       | 78       | 111     | 42       |

Table 16 River Monitoring Point Statistics (MA13 to MA16)

| Parameter | Units | Stat | MA13    | MA14    | MA15    | MA16 |
|-----------|-------|------|---------|---------|---------|------|
| Al        | mg/l  | min  | 0.01    | 0.01    | 0.01    | 0.01 |
|           |       | max  | 0.3     | 0.7     | 1.33    | 0.01 |
|           |       | mean | 0.07531 | 0.10118 | 0.11794 | 0.01 |

| Parameter    | Units | Stat  | MA13     | MA14     | MA15     | MA16    |
|--------------|-------|-------|----------|----------|----------|---------|
| Alkalinity   | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 27       | 28       | 15       | 230     |
|              |       | max   | 110      | 331      | 158      | 230     |
|              |       | mean  | 73.824   | 75.333   | 78.68    | 230     |
| As           | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 0.0002   | 0.0002   | 0.0004   | 0.0003  |
|              |       | max   | 0.0016   | 0.0028   | 0.006    | 0.0003  |
|              |       | mean  | 0.001057 | 0.001114 | 0.001237 | 0.0003  |
| Ca           | mg/l  | count | 44       | 44       | 43       | 1       |
|              |       | min   | 5        | 10       | 6        | 64      |
|              |       | max   | 20       | 37       | 87       | 64      |
|              |       | mean  | 13.078   | 18.843   | 29.14    | 64      |
| Cd           | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 0.00002  | 0.00002  | 0.00002  | 0.00002 |
|              |       | max   | 0.0037   | 0.0007   | 0.001    | 0.00002 |
|              |       | mean  | 0.000474 | 0.000397 | 0.000399 | 0.00002 |
| Cl           | mg/l  | count | 44       | 44       | 43       | 1       |
|              |       | min   | 4        | 4        | 3        | 32      |
|              |       | max   | 15       | 39       | 32       | 32      |
|              |       | mean  | 9.333    | 10.804   | 15.06    | 32      |
| Conductivity | mS/cm | count | 51       | 51       | 50       | 1       |
|              |       | min   | 73       | 93       | 52.5     | 720     |
|              |       | max   | 278      | 439      | 529      | 720     |
|              |       | mean  | 203.358  | 226.6863 | 290.578  | 720     |
| Cr           | mg/l  | count | 50       | 51       | 50       | 1       |
|              |       | min   | 0.001    | 0.001    | 0.001    | 0.002   |
|              |       | max   | 0.009    | 0.002    | 0.01     | 0.002   |
|              |       | mean  | 0.00186  | 0.00164  | 0.00193  | 0.002   |
| Cu           | mg/l  | count | 44       | 44       | 43       | 1       |
|              |       | min   | 0.0005   | 0.0005   | 0.0005   | 0.0012  |
|              |       | max   | 0.015    | 0.012    | 0.011    | 0.0012  |
|              |       | mean  | 0.00631  | 0.006163 | 0.006298 | 0.0012  |
| Fe           | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 0.005    | 0.005    | 0.005    | 0.005   |
|              |       | max   | 3.46     | 10.8     | 3.3      | 0.005   |
|              |       | mean  | 0.24778  | 0.51071  | 0.41308  | 0.005   |
| Hg           | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 0.00005  | 0.00005  | 0.00005  | 0.00005 |
|              |       | max   | 0.00033  | 0.0001   | 0.0001   | 0.00005 |
|              |       | mean  | 9.16E-05 | 8.52E-05 | 8.49E-05 | 0.00005 |
| K            | mg/l  | count | 44       | 44       | 43       | 1       |
|              |       | min   | 1        | 1        | 0        | 17      |
|              |       | max   | 6        | 20       | 13       | 17      |
|              |       | mean  | 3.24     | 4.86     | 5.64     | 17      |
| Mg           | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 5        | 4        | 1        | 44      |
|              |       | max   | 22       | 19       | 44       | 44      |
|              |       | mean  | 14.804   | 12.28    | 14.24    | 44      |
| Mn           | mg/l  | count | 51       | 50       | 50       | 1       |
|              |       | min   | 0.001    | 0.001    | 0.001    | 0.093   |
|              |       | max   | 0.121    | 3.69     | 0.26     | 0.093   |
|              |       | mean  | 0.01278  | 0.13476  | 0.03572  | 0.093   |
| Mo           | mg/l  | count | 51       | 51       | 50       | 1       |
|              |       | min   | 0.001    | 0.001    | 0.001    | 0.001   |
|              |       | max   | 0.043    | 0.02     | 0.007    | 0.001   |
|              |       | mean  | 0.00361  | 0.00273  | 0.00237  | 0.001   |
|              |       | count | 44       | 44       | 43       | 1       |



| Parameter        | Units    | Stat  | MA13     | MA14     | MA15     | MA16   |
|------------------|----------|-------|----------|----------|----------|--------|
| N                | mg/l     | min   | 0.1      | 0.1      | 0.1      | 0.5    |
|                  |          | max   | 1.1      | 3.2      | 0.8      | 0.5    |
|                  |          | mean  | 0.5167   | 0.3941   | 0.362    | 0.5    |
|                  |          | count | 51       | 51       | 50       | 1      |
| NH3 (as N)       | mg/l     | min   | 0.01     | 0.01     | 0.01     | 0.14   |
|                  |          | max   | 0.78     | 0.79     | 0.51     | 0.14   |
|                  |          | mean  | 0.2257   | 0.2294   | 0.216    | 0.14   |
|                  |          | count | 51       | 51       | 50       | 1      |
| Na               | mg/l     | min   | 2        | 2        | 2        | 15     |
|                  |          | max   | 8        | 28       | 37       | 15     |
|                  |          | mean  | 4.84     | 6.82     | 9.14     | 15     |
|                  |          | count | 51       | 51       | 50       | 1      |
| Ni               | mg/l     | min   | 0.001    | 0.001    | 0.001    | 0.007  |
|                  |          | max   | 0.385    | 0.009    | 0.022    | 0.007  |
|                  |          | mean  | 0.01182  | 0.00284  | 0.00377  | 0.007  |
|                  |          | count | 44       | 44       | 43       | 1      |
| Pb               | mg/l     | min   | 0.0003   | 0.0003   | 0.0003   | 0.0003 |
|                  |          | max   | 0.032    | 0.015    | 0.016    | 0.0003 |
|                  |          | mean  | 0.004712 | 0.004584 | 0.004362 | 0.0003 |
|                  |          | count | 51       | 51       | 50       | 1      |
| SO4              | mg/l     | min   | 9        | 7        | 3        | 120    |
|                  |          | max   | 43       | 78       | 128      | 120    |
|                  |          | mean  | 22.255   | 35.588   | 57.78    | 120    |
|                  |          | count | 51       | 51       | 50       | 1      |
| Se               | mg/l     | min   | 0.0009   | 0.0005   | 0.0005   | 0.001  |
|                  |          | max   | 0.0034   | 0.007    | 0.008    | 0.001  |
|                  |          | mean  | 0.001625 | 0.001361 | 0.001452 | 0.001  |
|                  |          | count | 51       | 51       | 50       | 1      |
| Suspended Solids | mg/l     | min   | 1        | 1        | 1        | 10     |
|                  |          | max   | 38       | 157      | 57       | 10     |
|                  |          | mean  | 11.87    | 18.16    | 14.55    | 10     |
|                  |          | count | 50       | 50       | 50       | 1      |
| Zn               | mg/l     | min   | 0.003    | 0.002    | 0.002    | 0.009  |
|                  |          | max   | 0.089    | 0.19     | 0.04     | 0.009  |
|                  |          | mean  | 0.01571  | 0.02033  | 0.01518  | 0.009  |
|                  |          | count | 51       | 51       | 50       | 1      |
| pH               | pH units | min   | 7.1      | 7        | 6.8      | 7.8    |
|                  |          | max   | 8.6      | 8.4      | 8.5      | 7.8    |
|                  |          | mean  | 7.822    | 7.798    | 7.832    | 7.8    |
|                  |          | count | 50       | 51       | 50       | 1      |

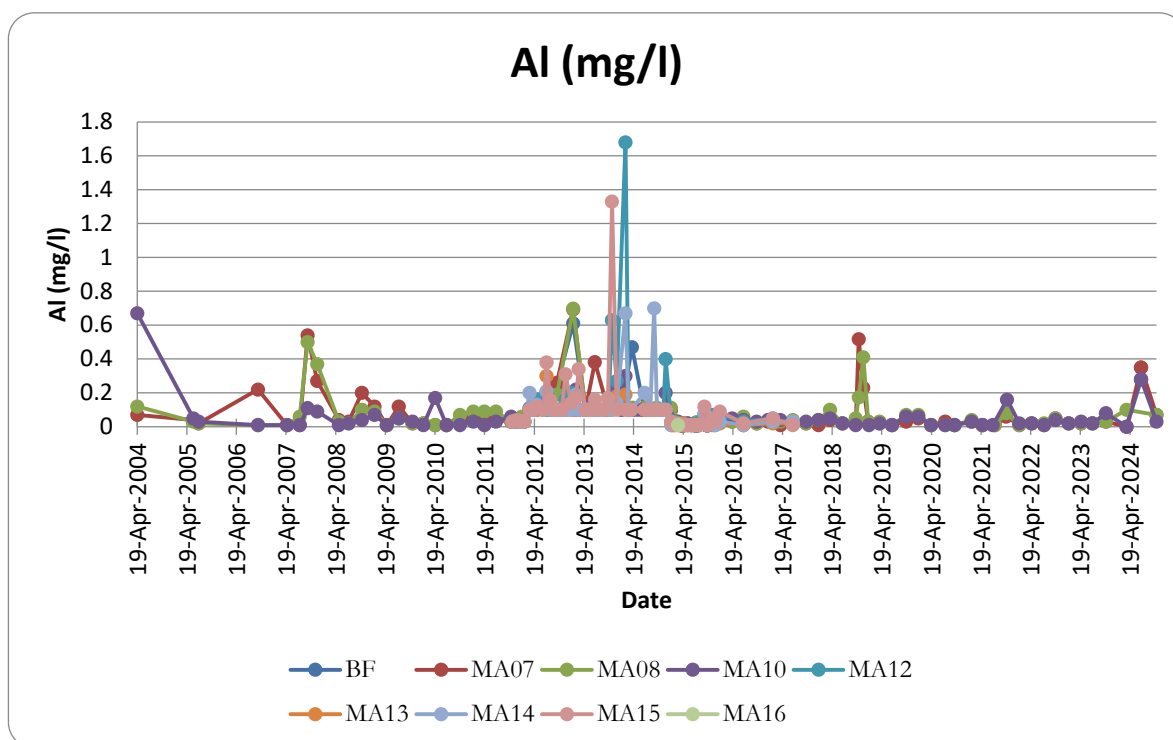


Figure 229: Al Concentration timeseries within the River

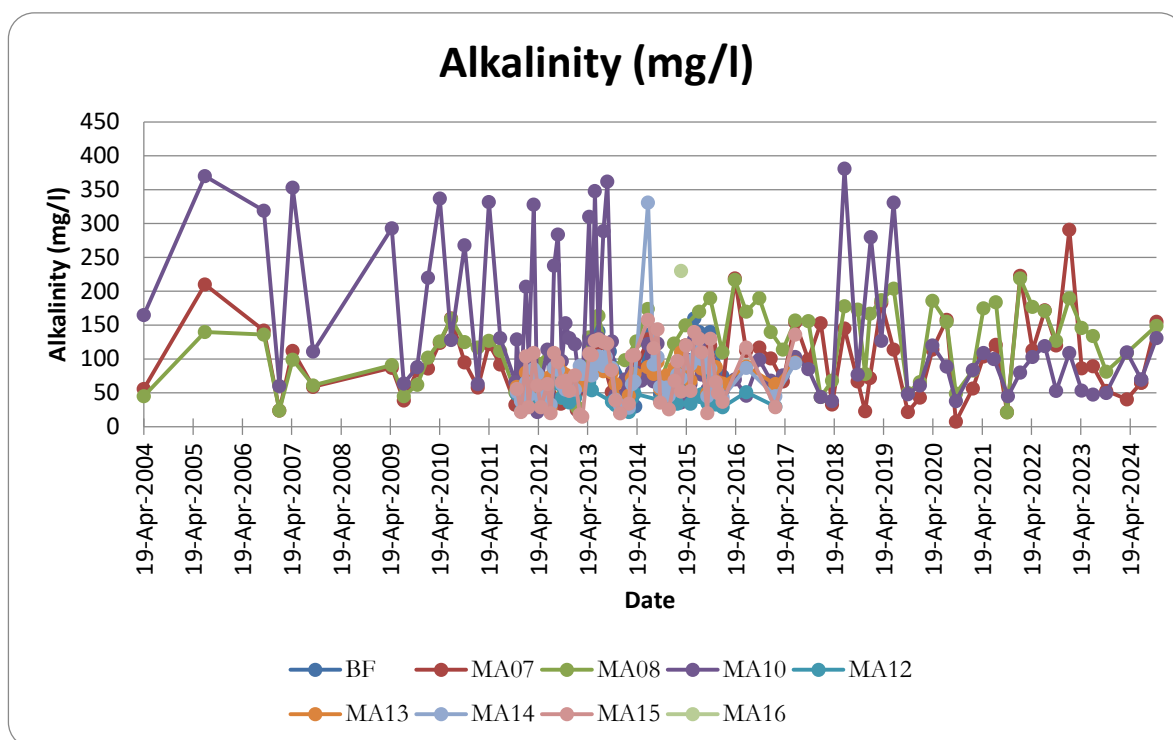


Figure 230: Alkalinity Concentration timeseries within the River

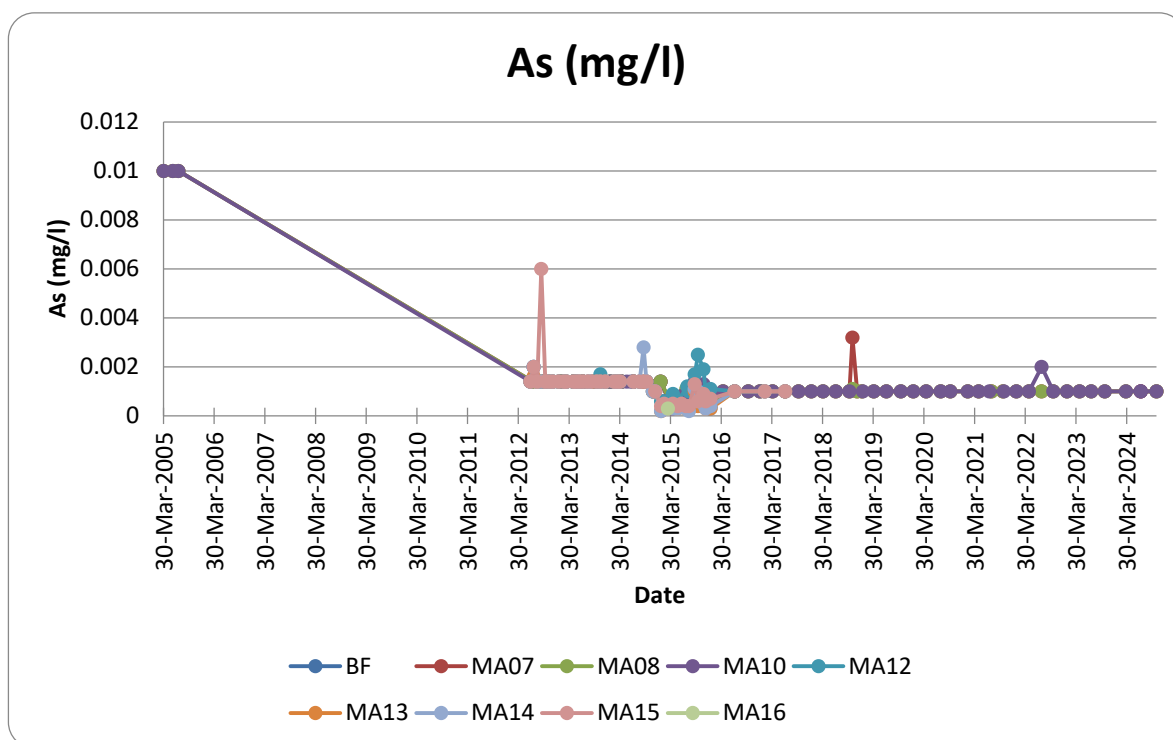


Figure 231: As Concentration timeseries within the River

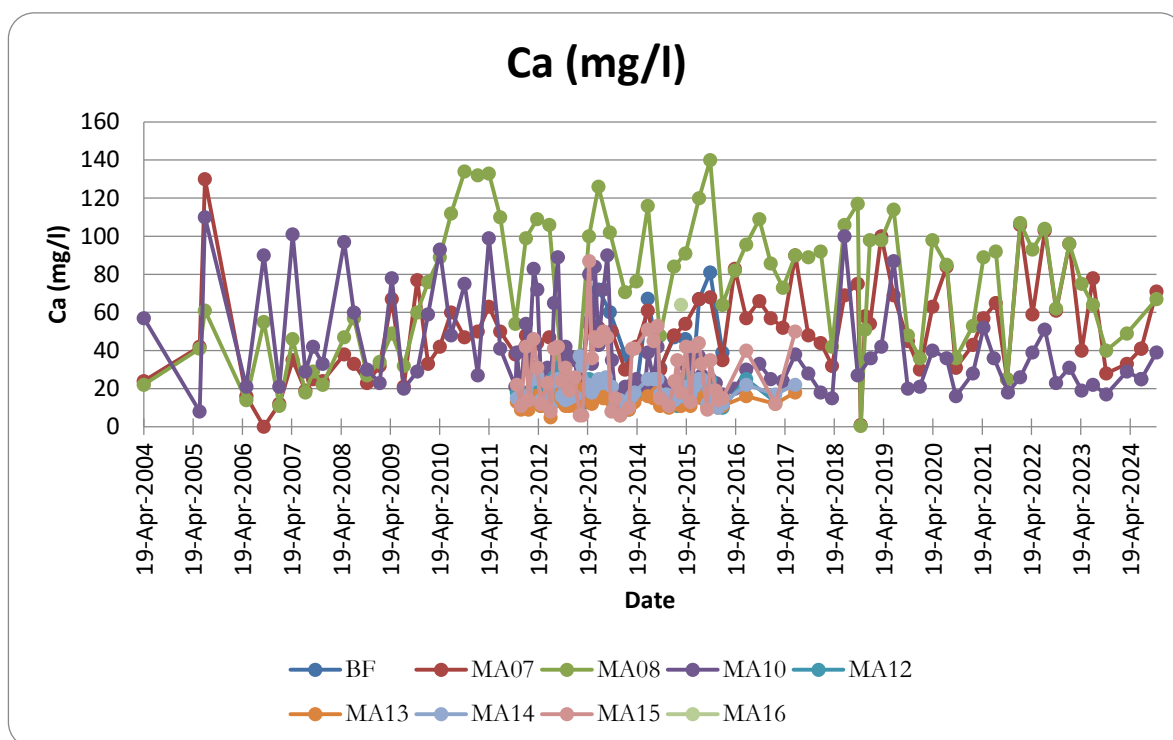


Figure 232: Ca Concentration timeseries within the River

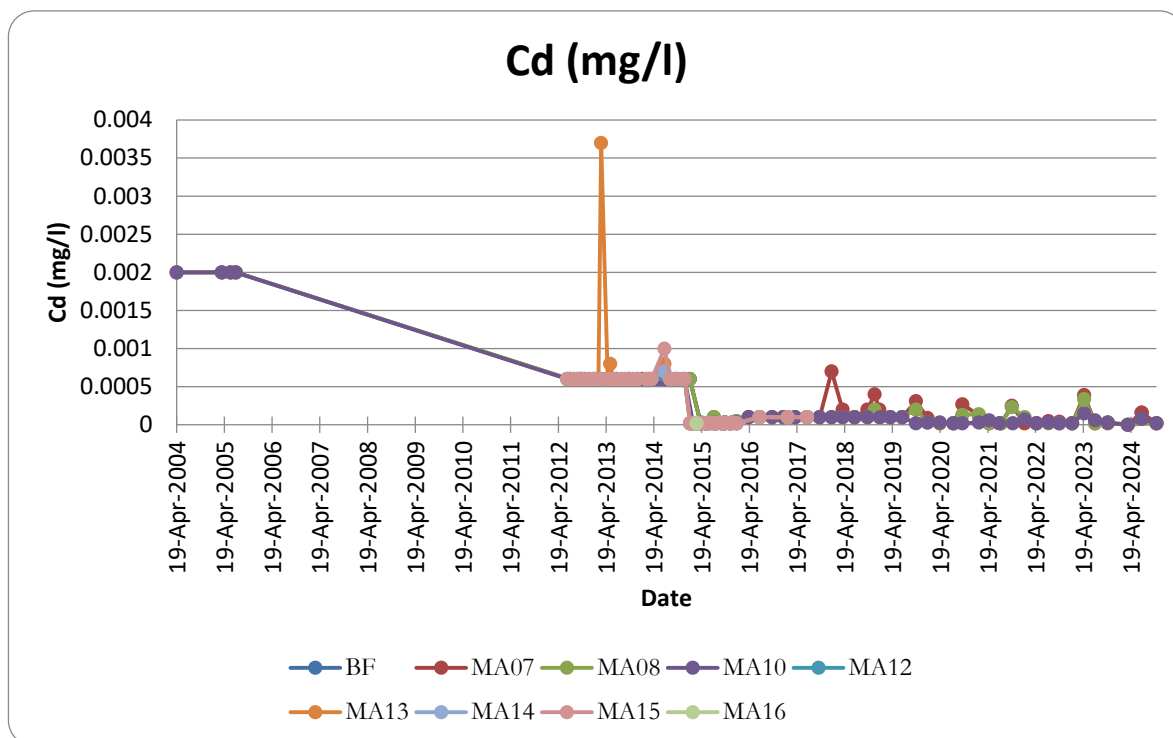


Figure 233: Cd Concentration timeseries within the River

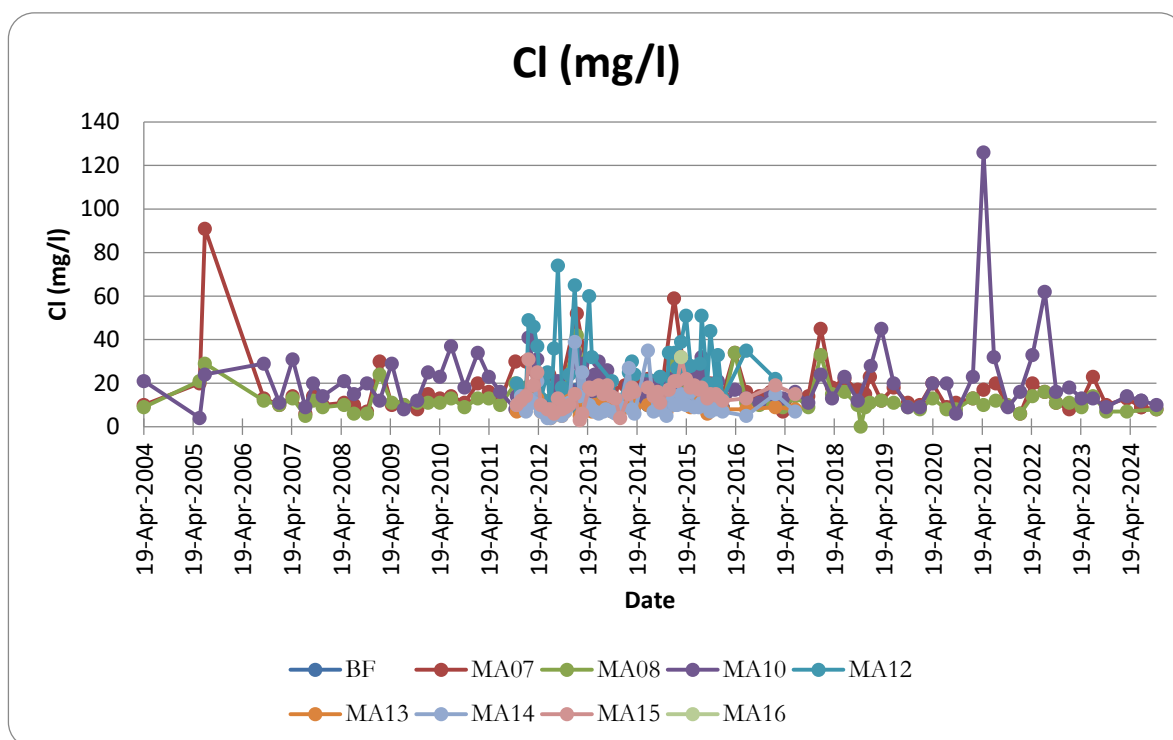


Figure 234: Cl Concentration timeseries within the River

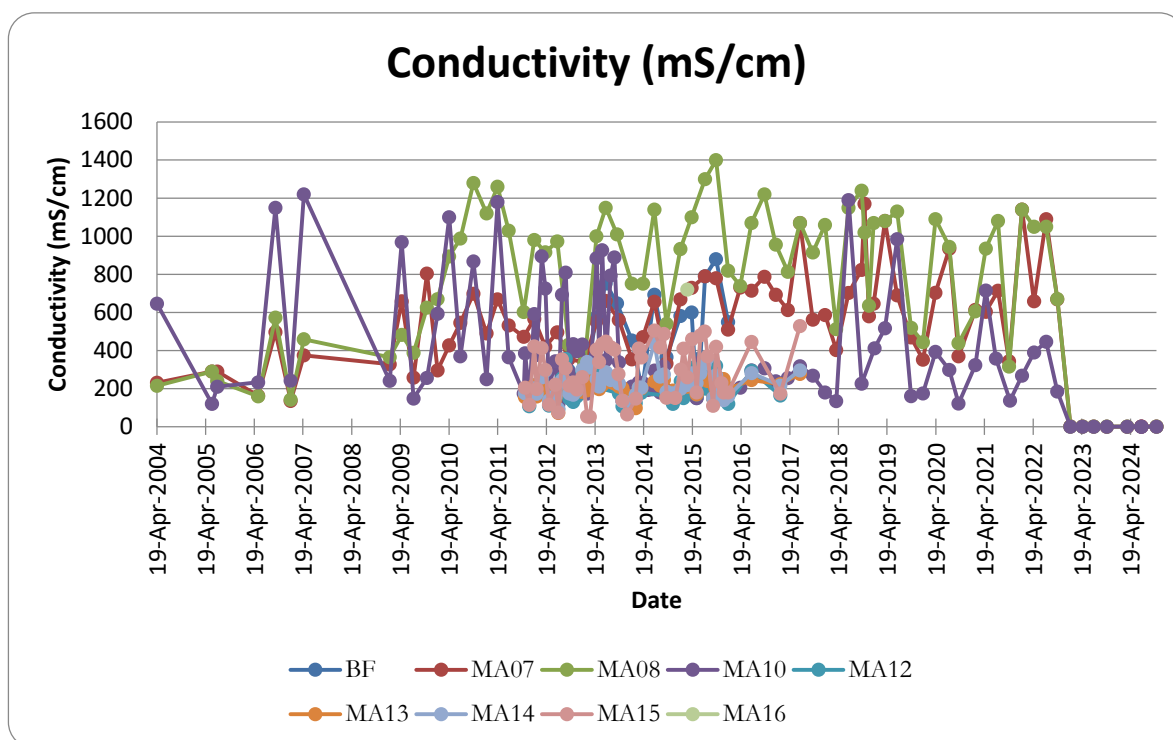


Figure 235: Electrical Conductivity timeseries within the River

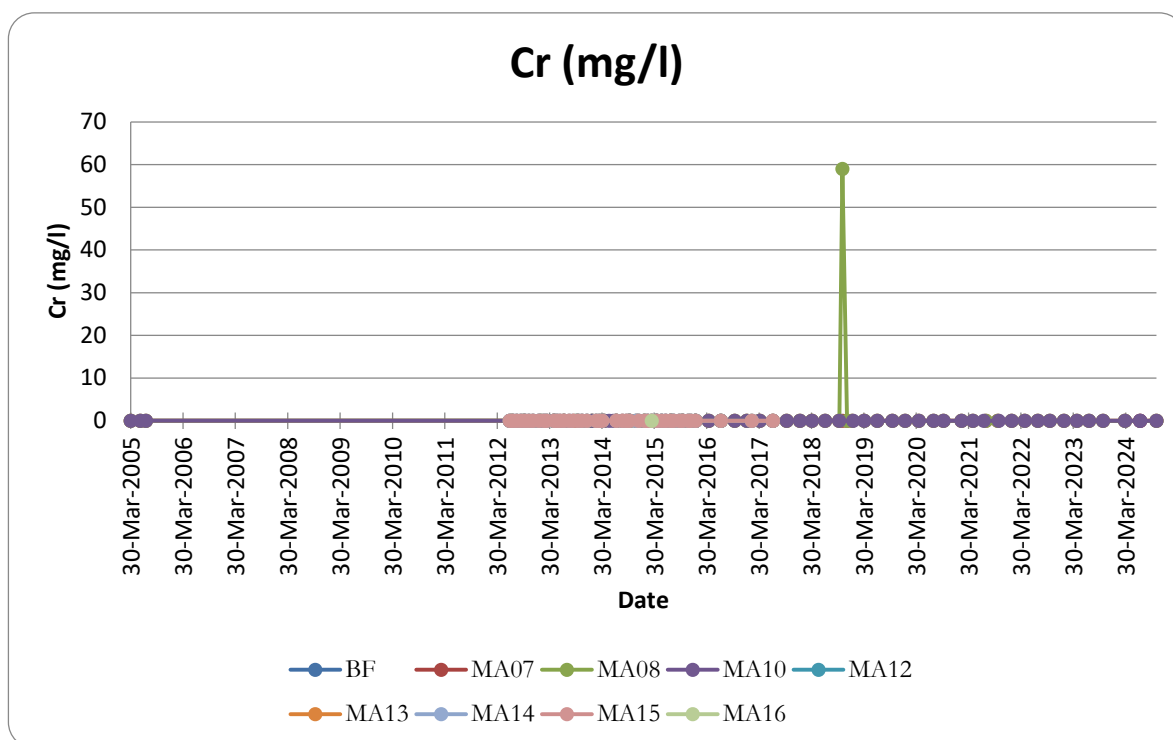


Figure 236:Cr Concentration timeseries within the River

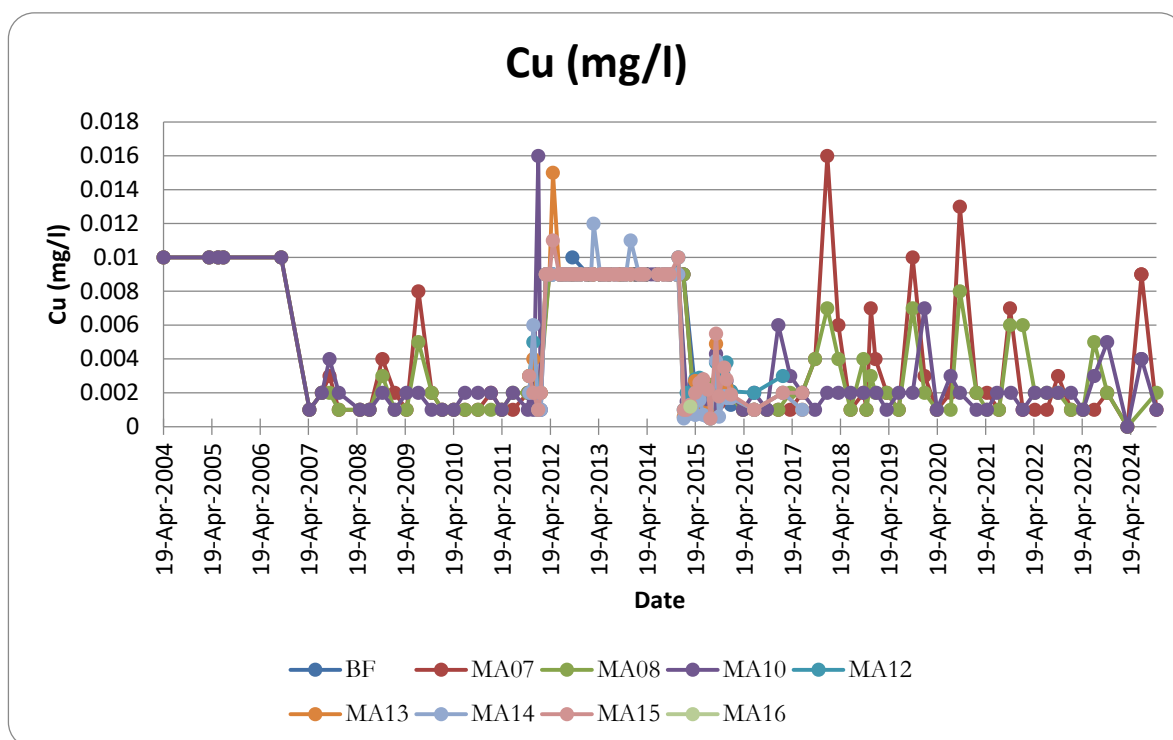


Figure 237: Cu Concentration timeseries within the River

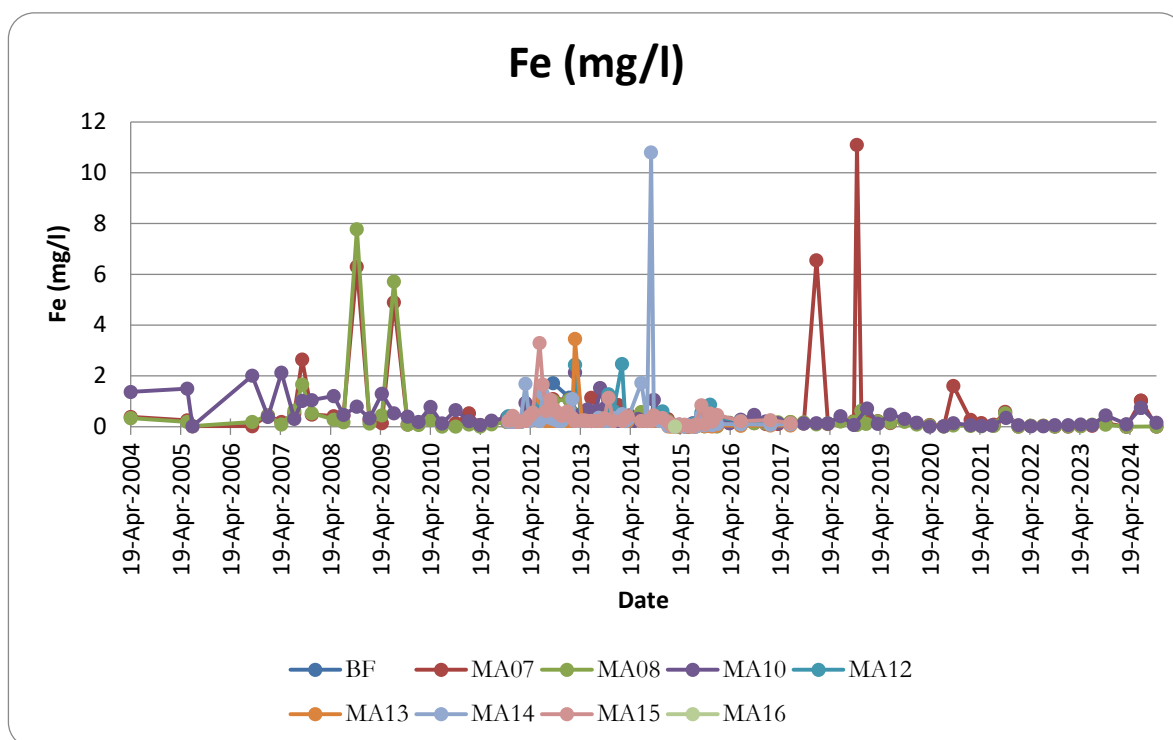


Figure 238: Fe Concentration timeseries within the River

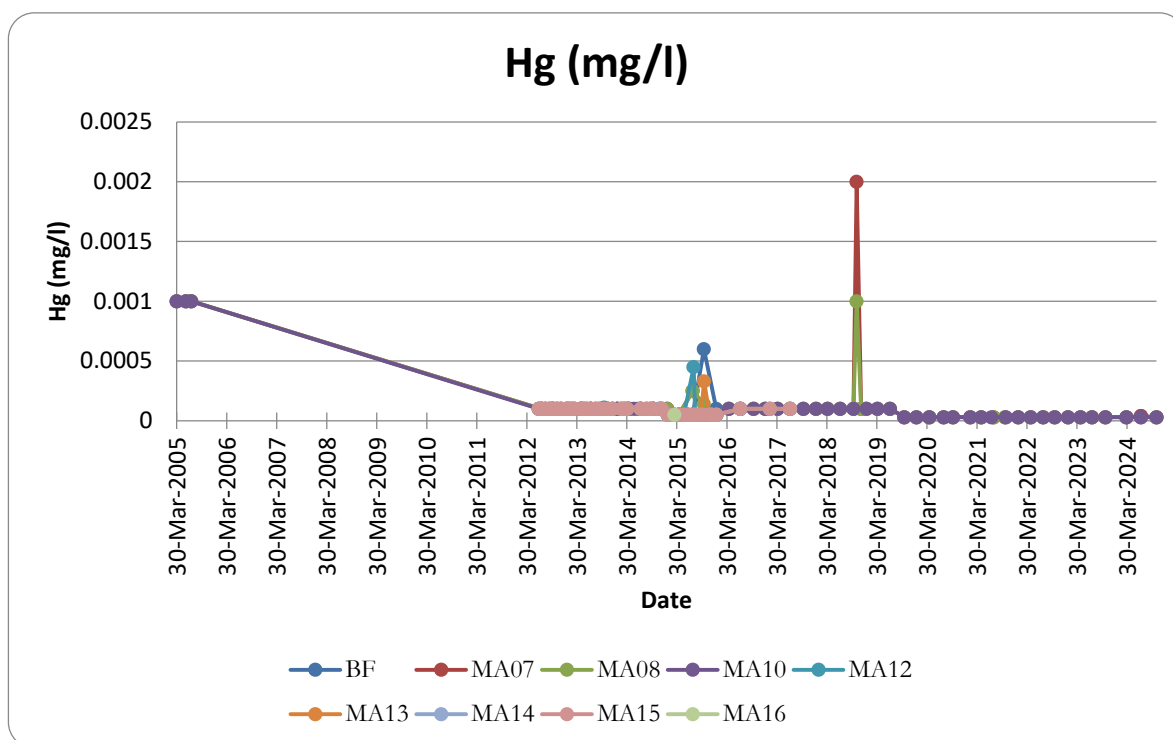


Figure 239: Hg Concentration timeseries within the River

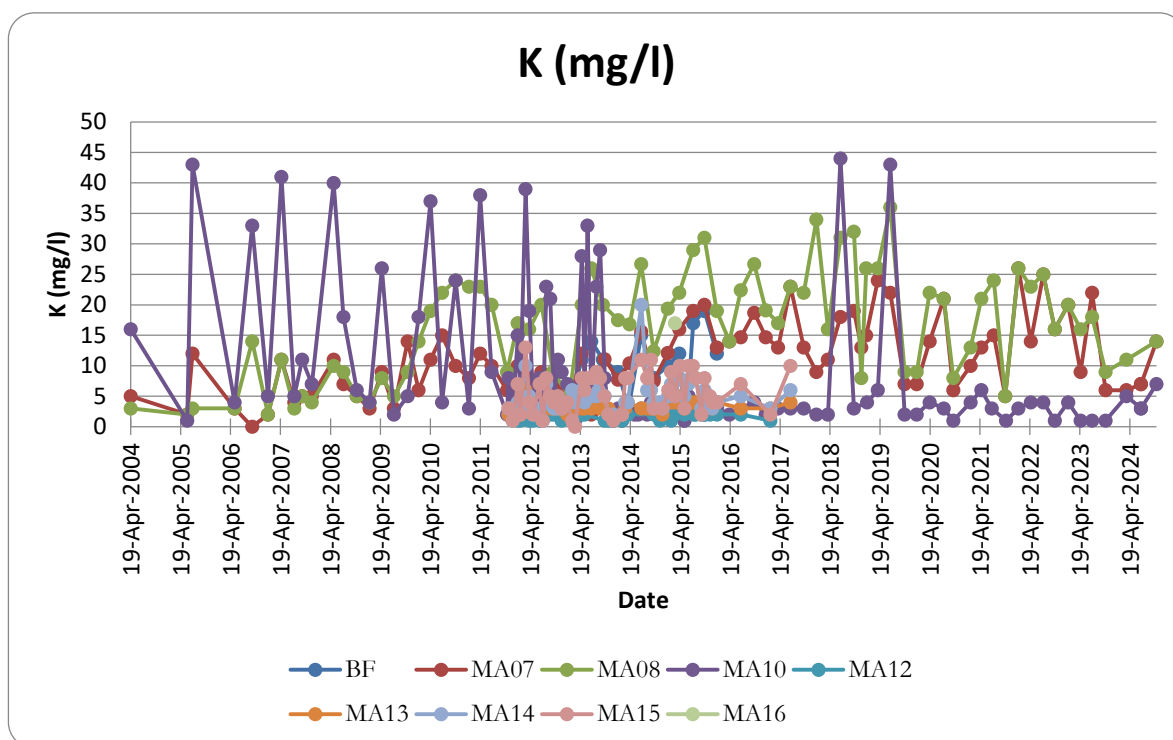


Figure 240: K Concentration timeseries within the River

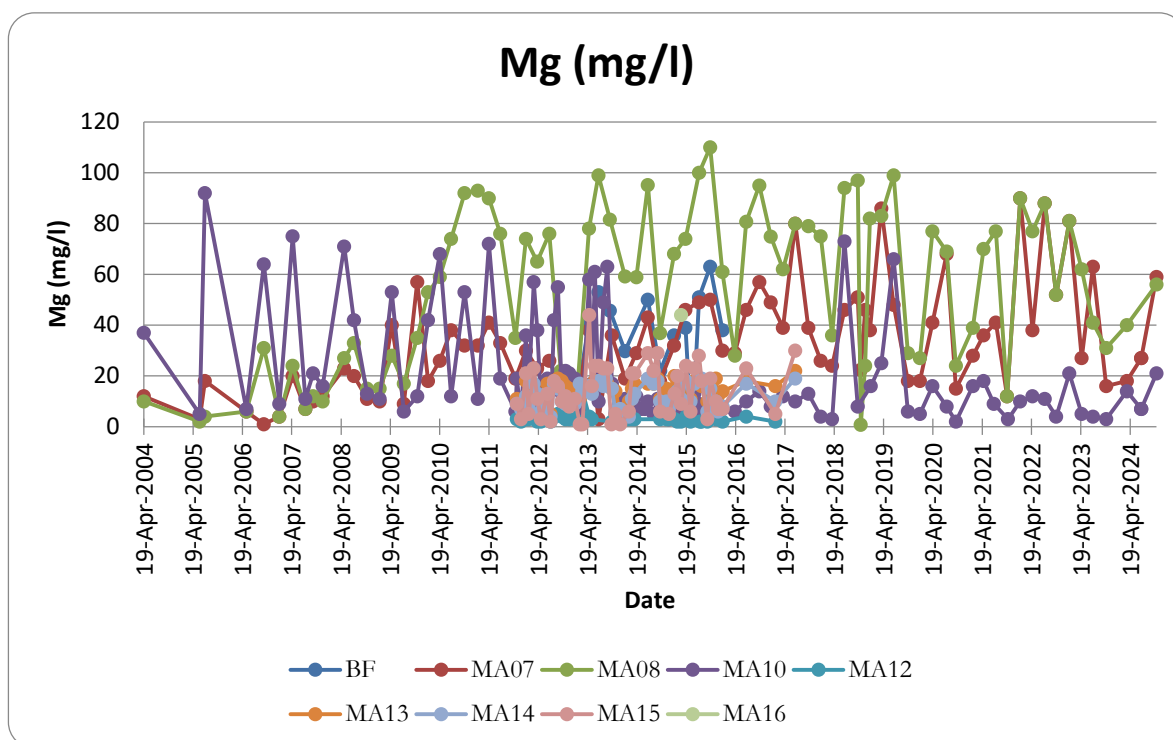


Figure 241: Mg Concentration timeseries within the River

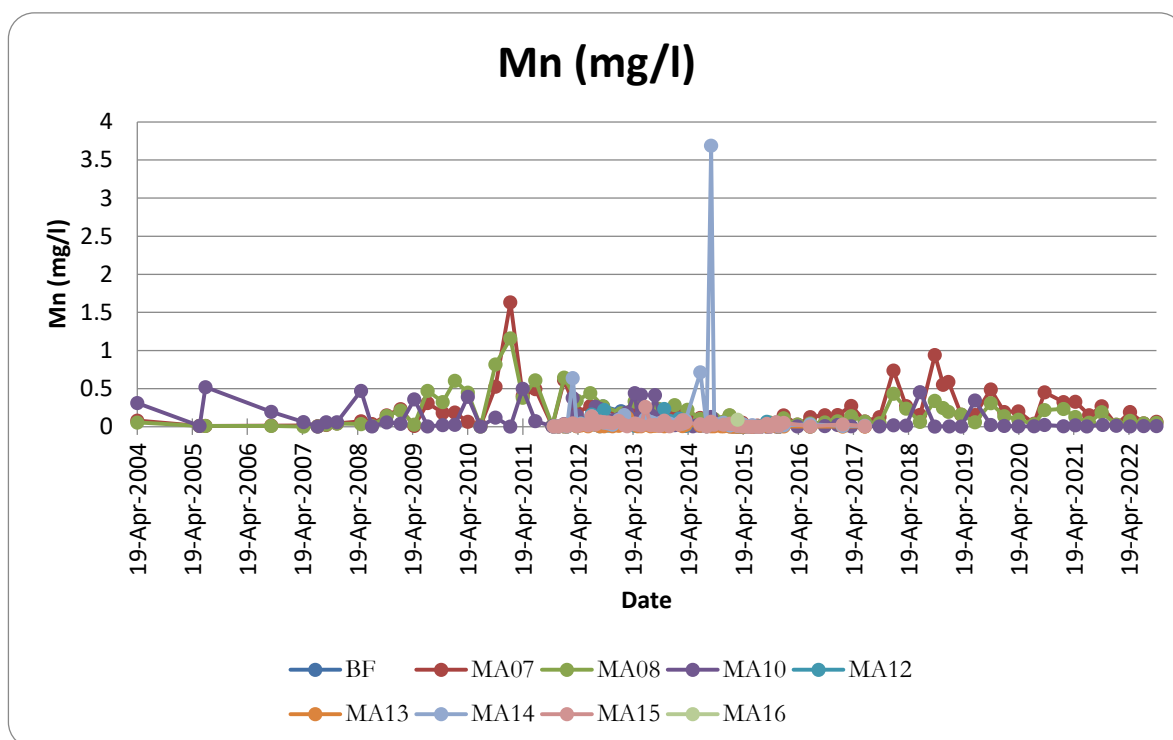


Figure 242: Mn Concentration timeseries within the River

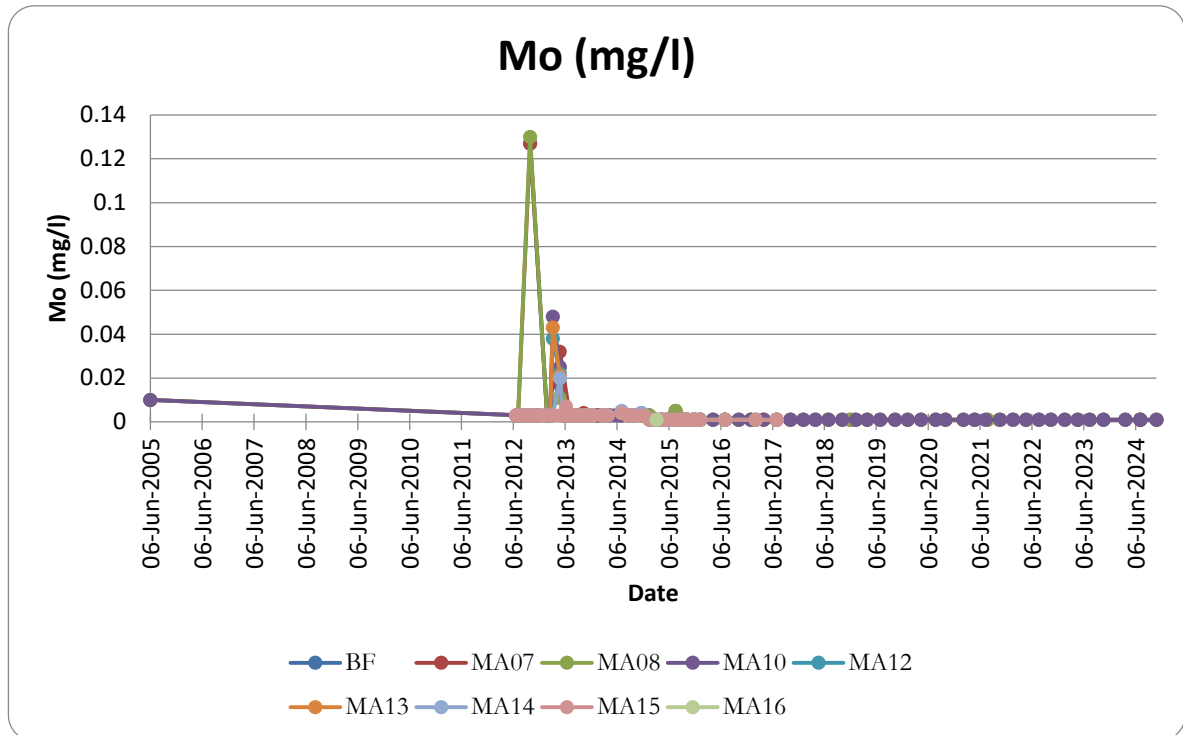


Figure 243: Mo Concentration timeseries within the River

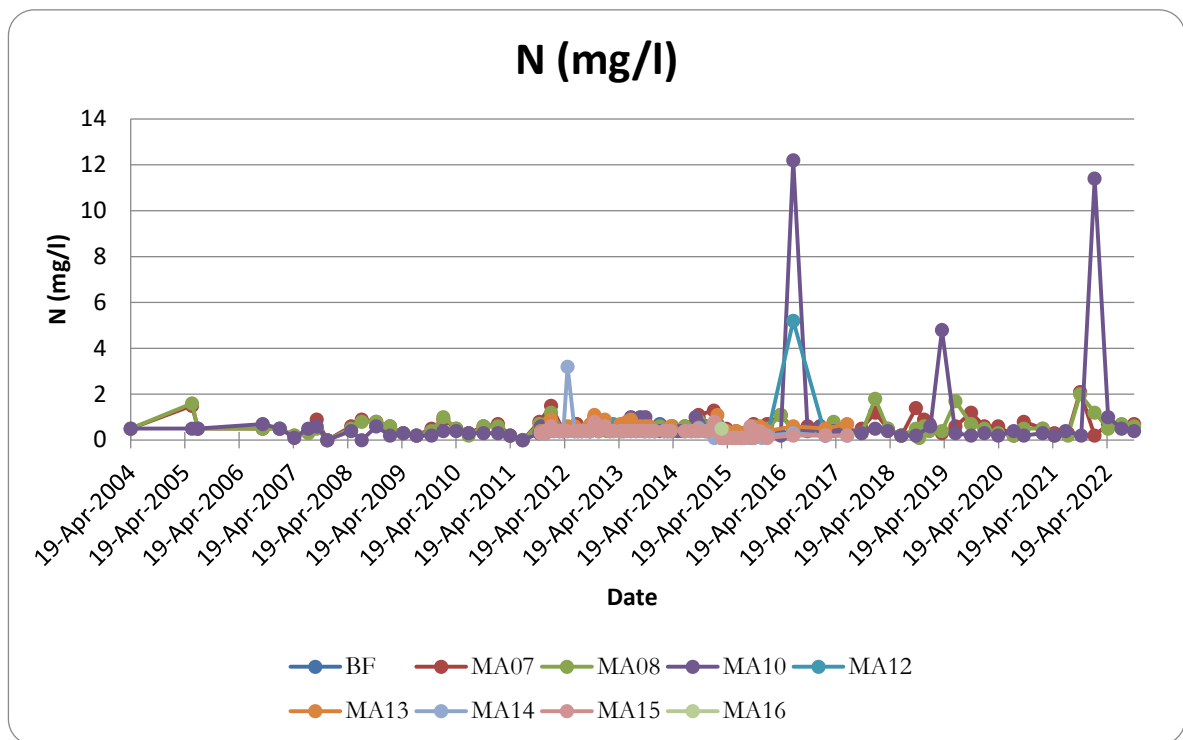


Figure 244: N Concentration timeseries within the River

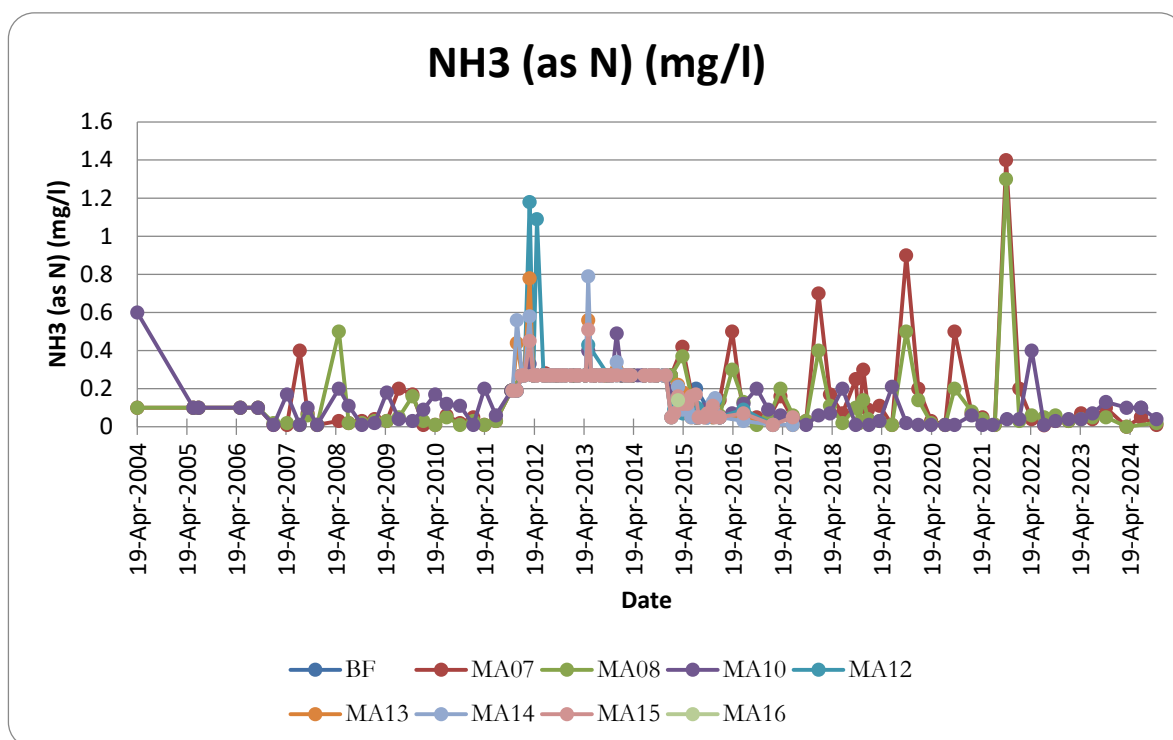


Figure 245: NH3 (as N) Concentration timeseries within the River

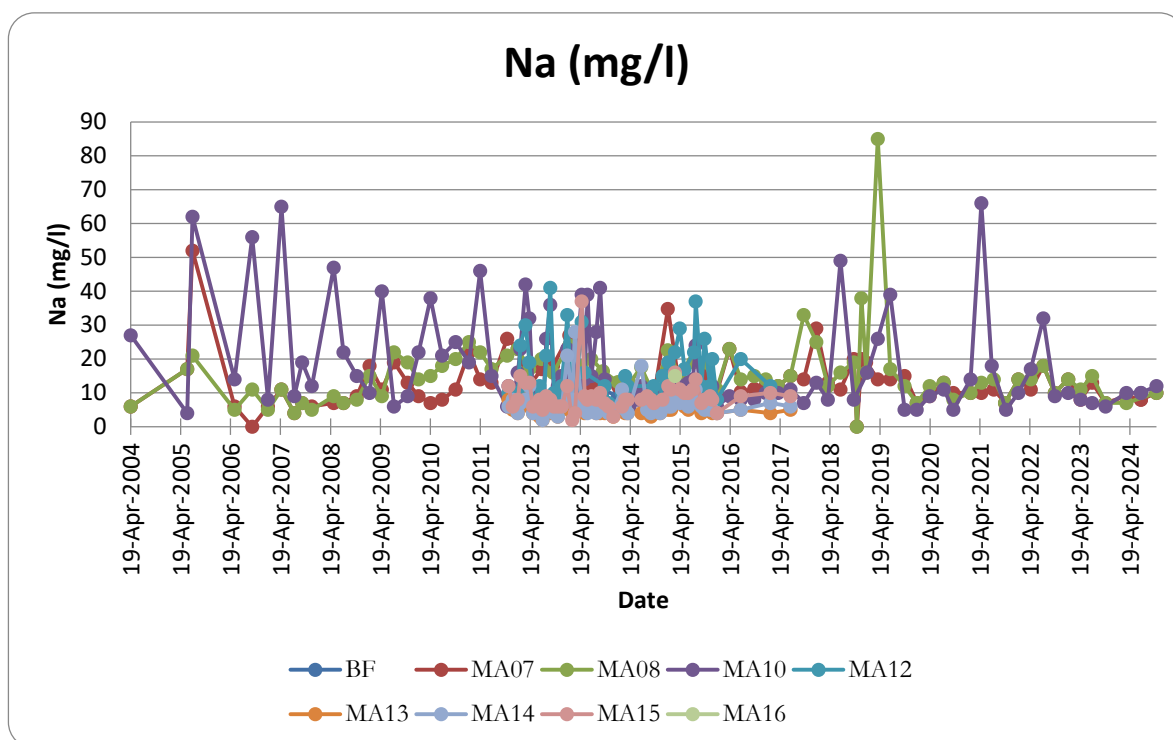


Figure 246: Na Concentration timeseries within the River

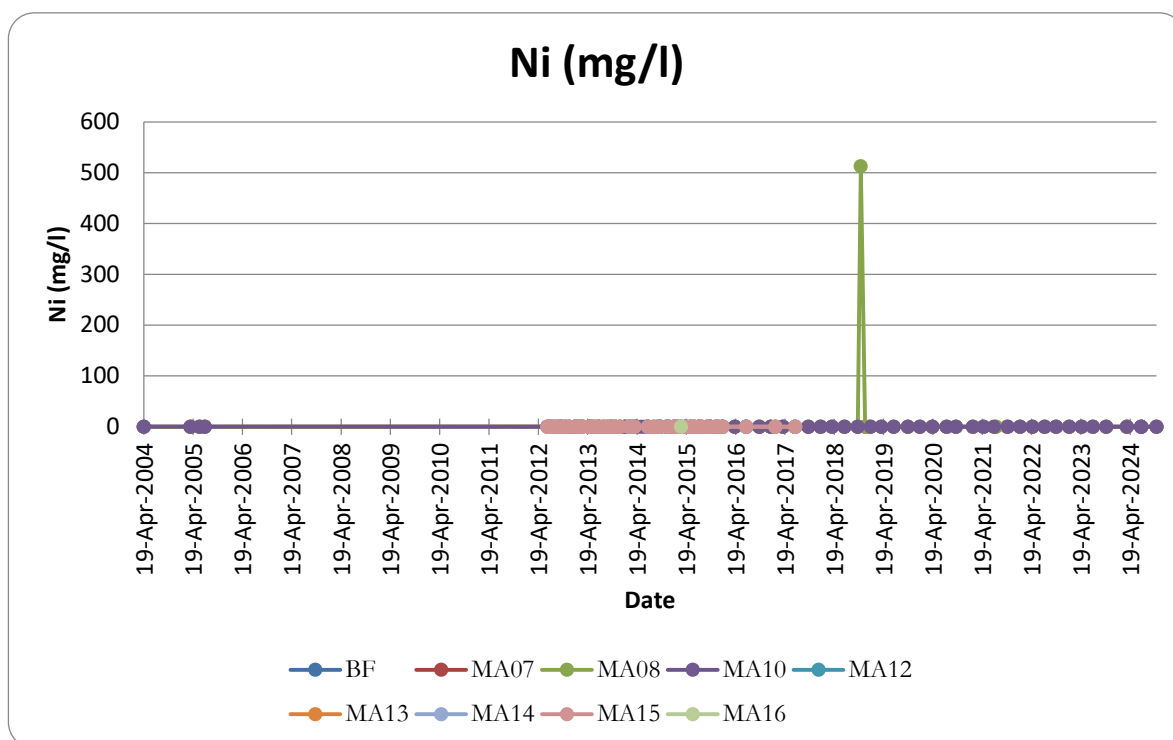


Figure 247: Ni Concentration timeseries within the River

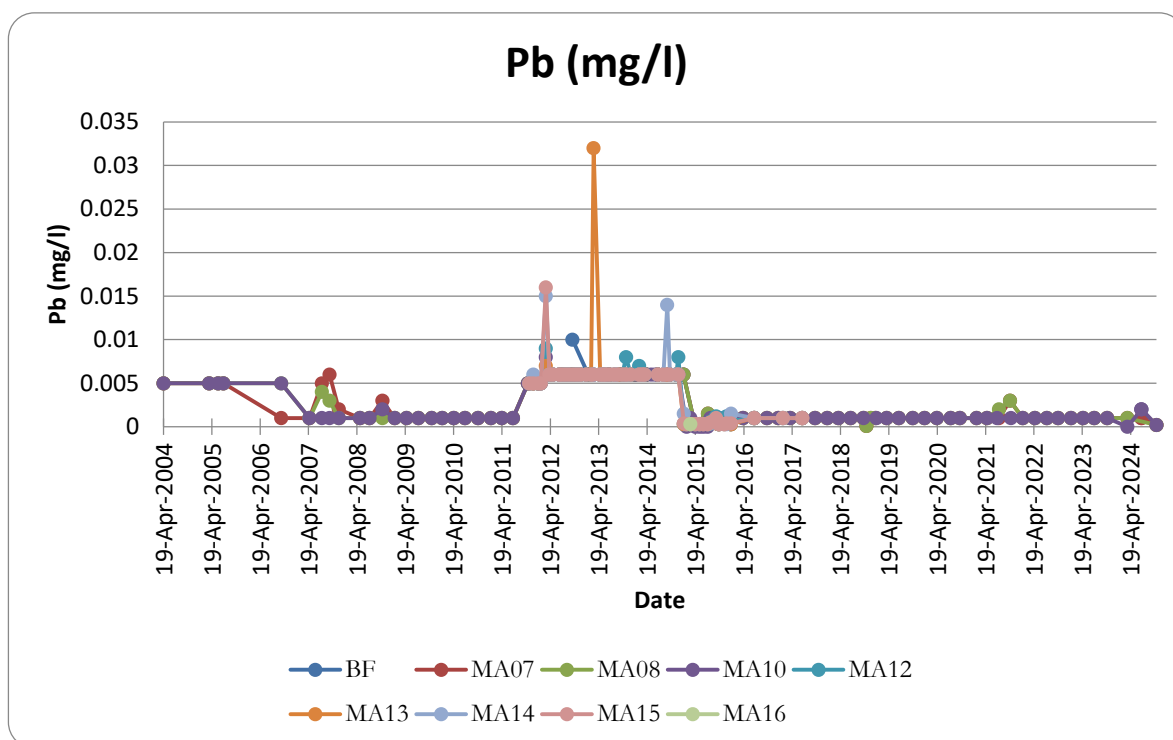


Figure 248: Pb Concentration timeseries within the River

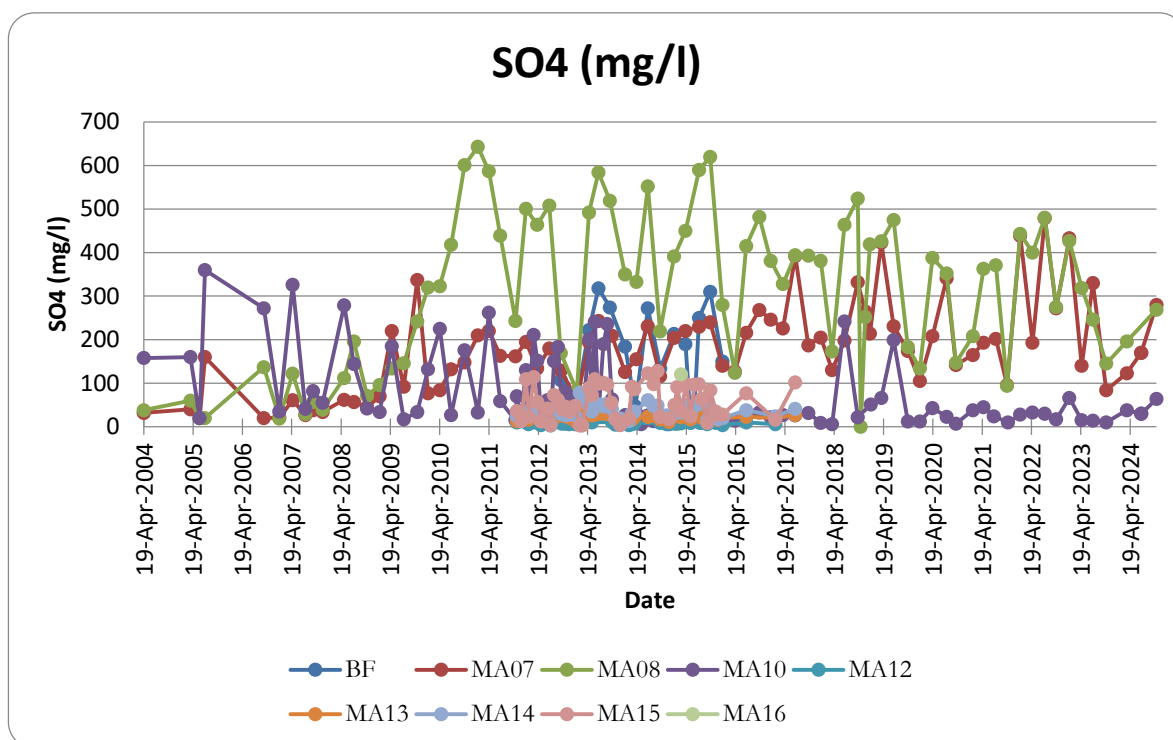
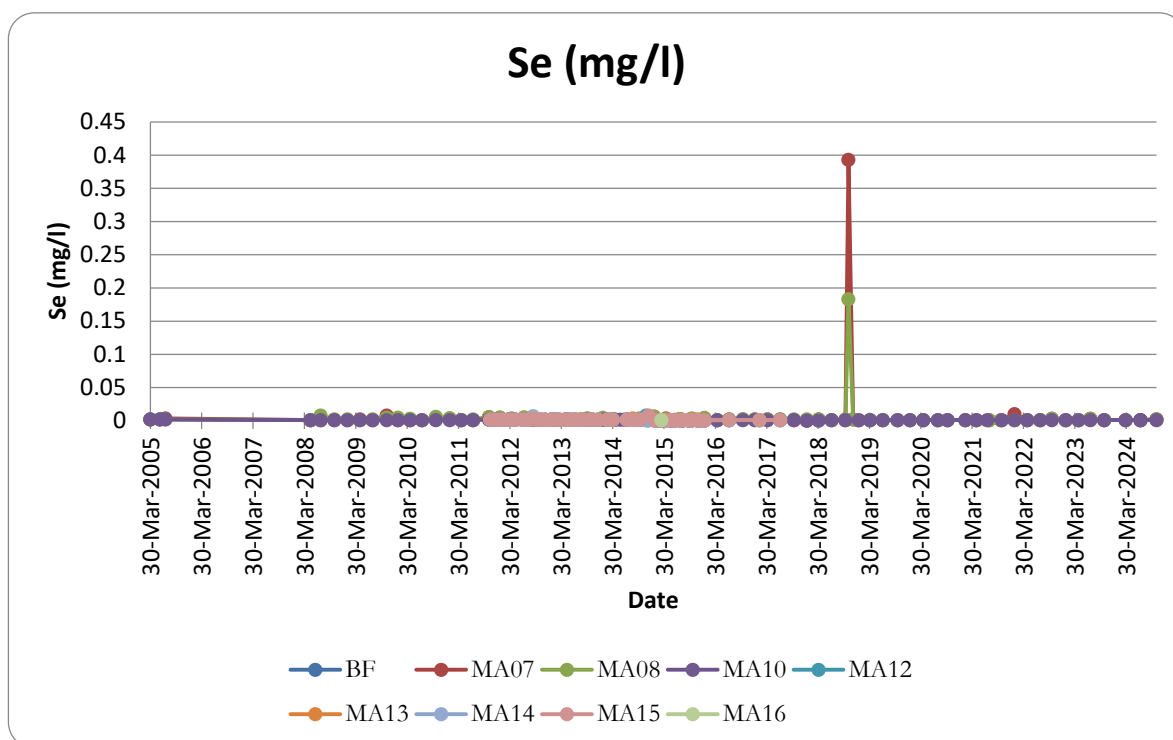
Figure 249: SO<sub>4</sub> Concentration timeseries within the River

Figure 250: Se Concentration timeseries within the River

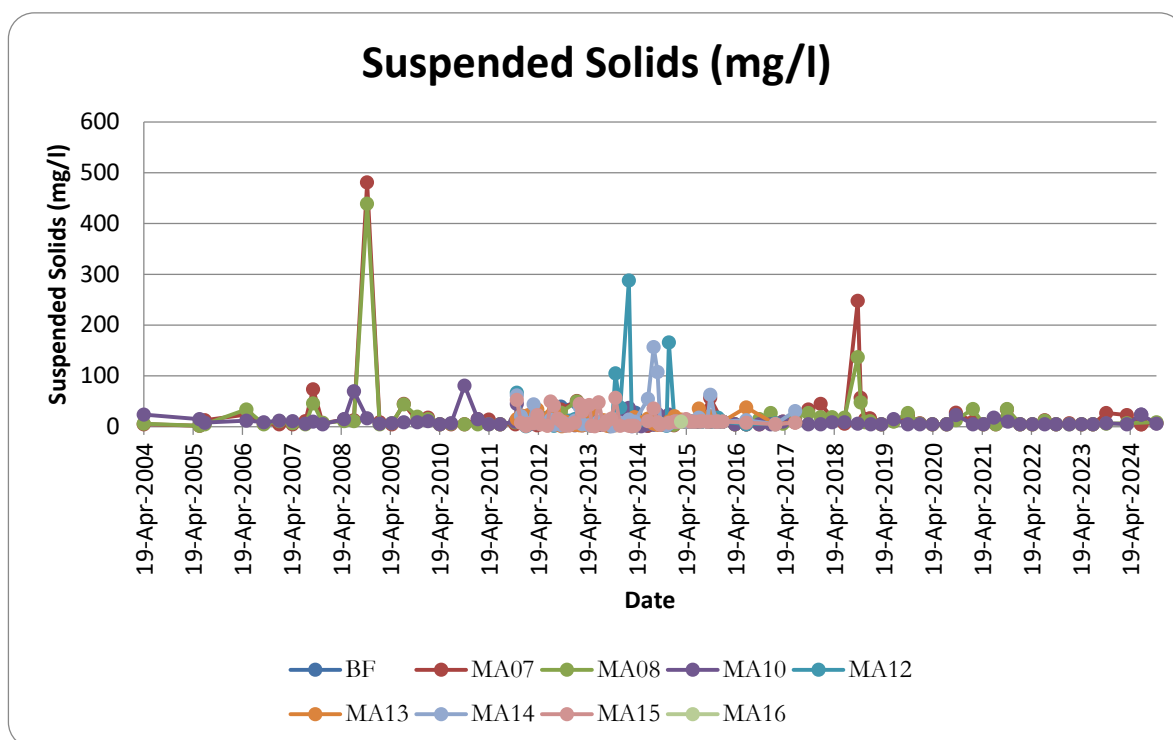


Figure 251: Suspended Solids Concentration timeseries within the River

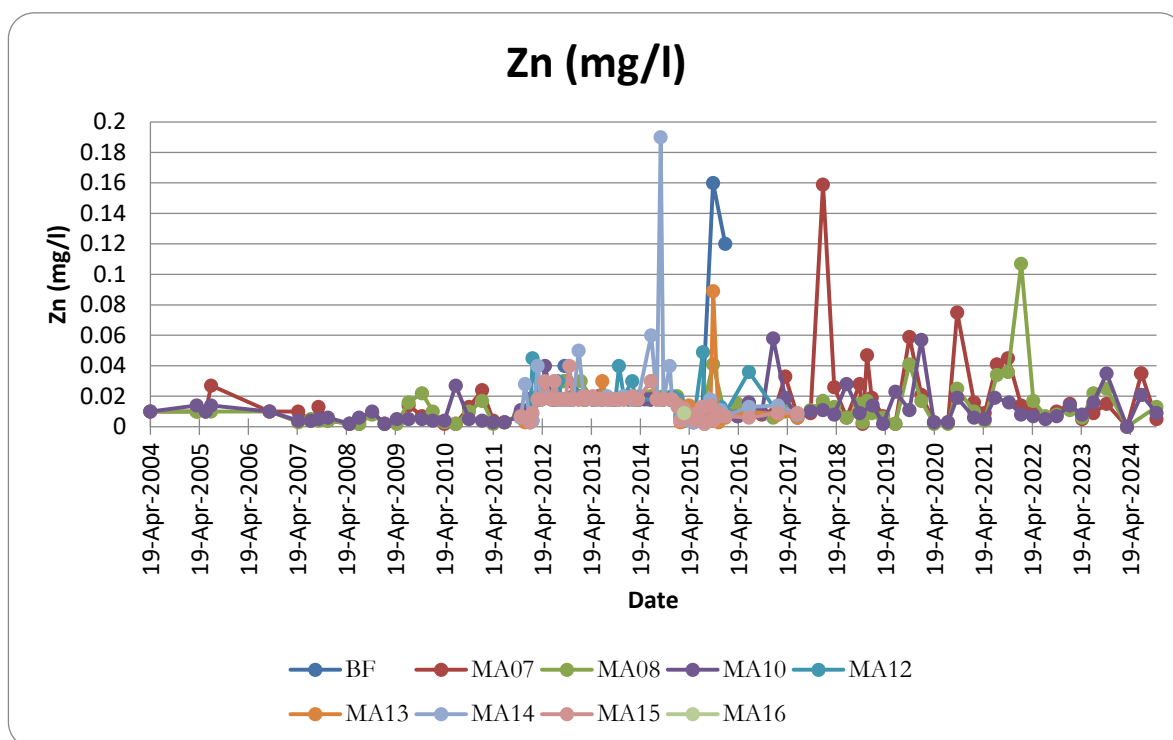


Figure 252: Zn Concentration timeseries within the River

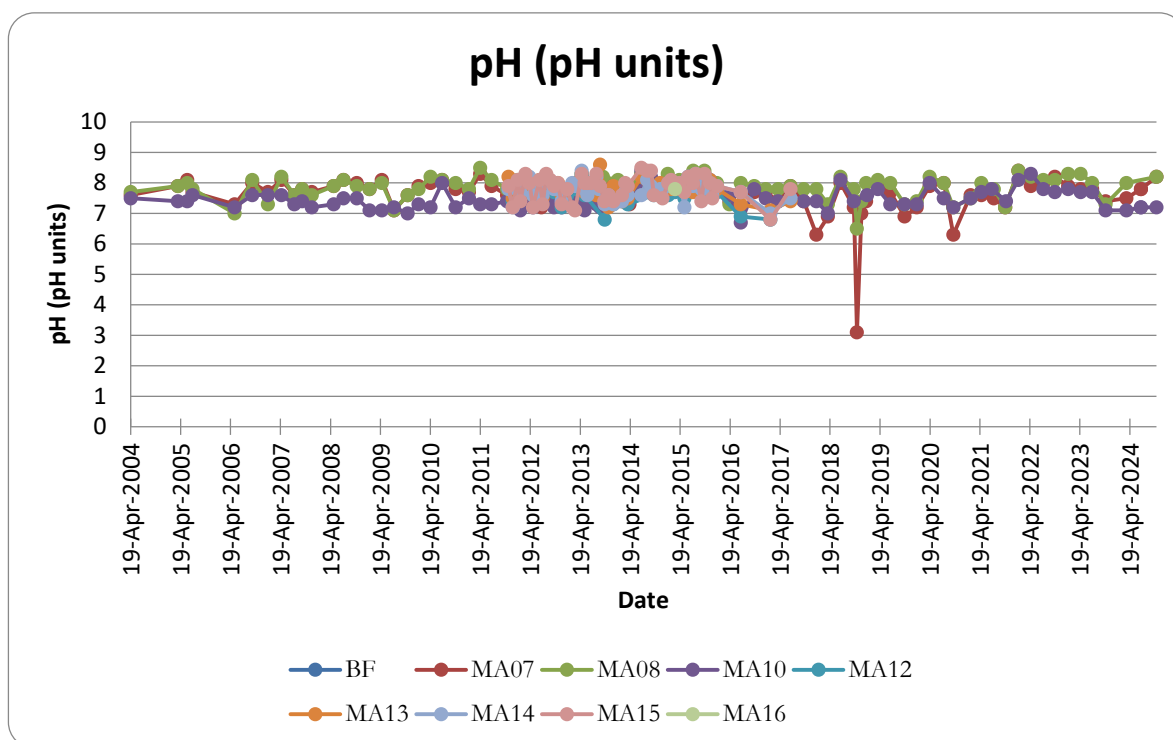


Figure 253: pH Concentration timeseries within the River